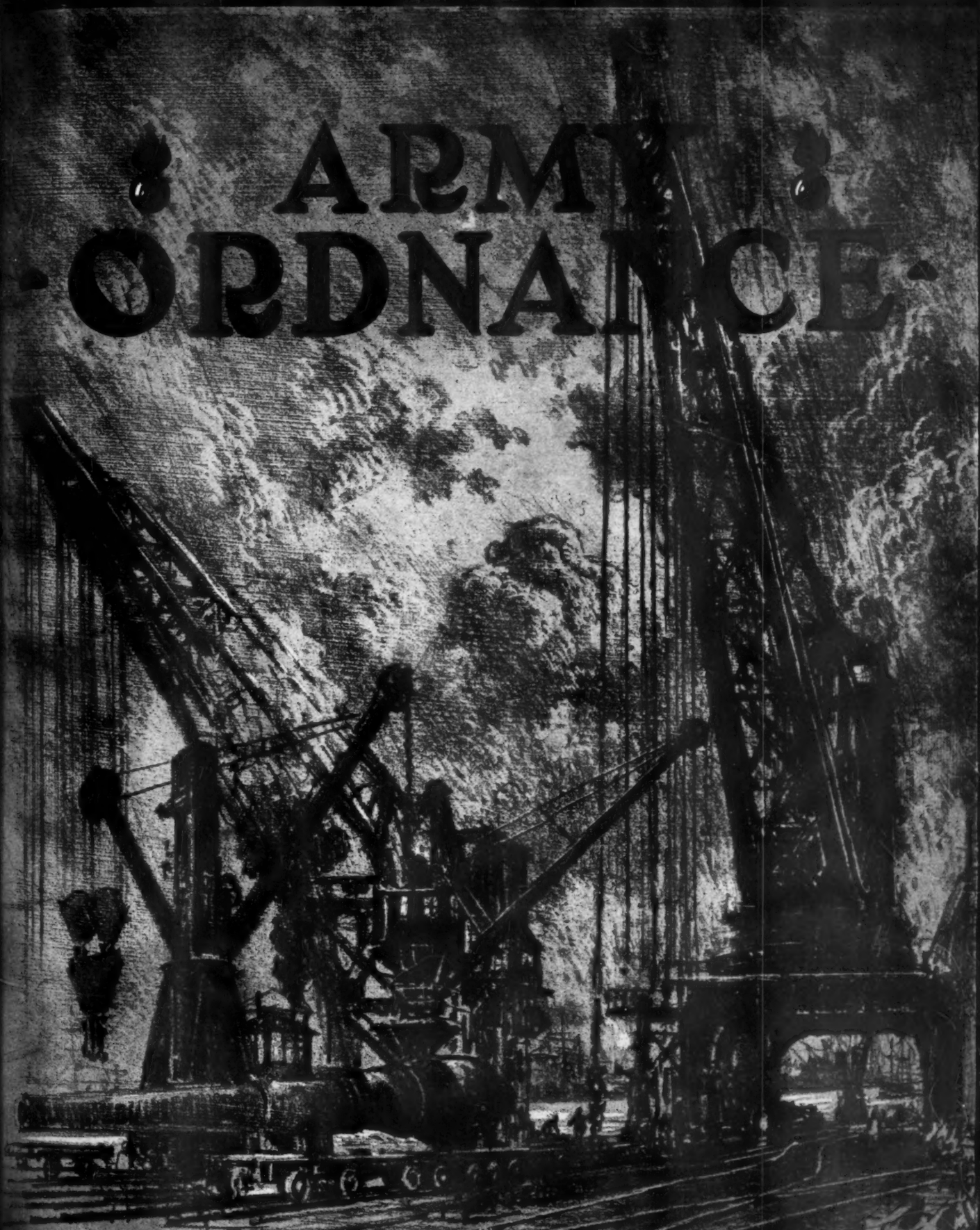
ARMY ORDNANCE



THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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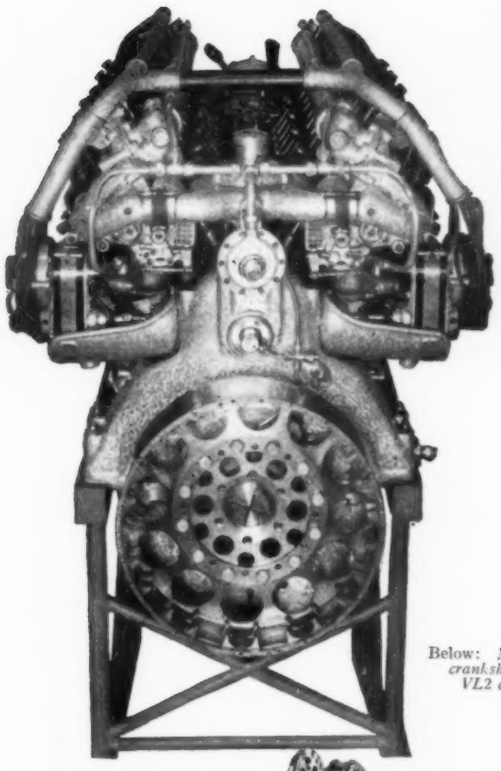

Above: *Maybach 12-cylinder, 600 H.P. airship engine, same type as engine used in "Graf Zeppelin," mfd. by Maybach Motor Co., Friedrichshafen*

Nickel Alloy Steel Parts in Maybach Engines

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Below: *Nickel Alloy Steel crankshaft of Maybach VL2 airship engine*

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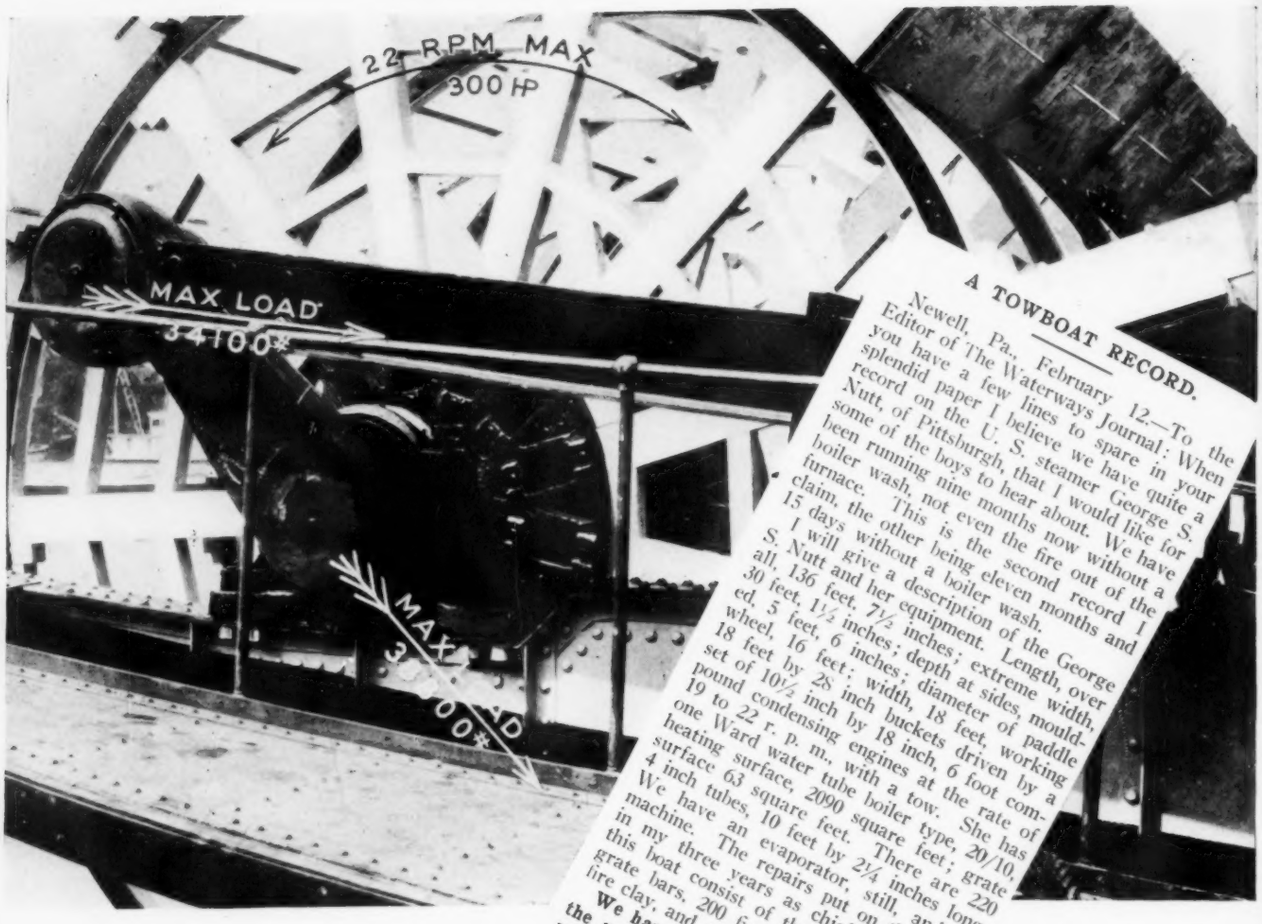

A TOWBOAT RECORD.

Newell, Pa., February 12.—To the Editor of The Waterways Journal: When you have a few lines to spare in your splendid paper I believe we have quite a record on the U. S. steamer George S. Nutt, of Pittsburgh, that I would like for some of the boys to hear about. We have been running nine months now without a boiler wash, not even the fire out of the furnace. This is the second record I claim, the other being eleven months and 15 days without a boiler wash.

I will give a description of the George S. Nutt and her equipment. Length, over all, 136 feet. 7½ inches; extreme width, 30 feet, 1½ inches; depth at sides, moulded, 5 feet, 6 inches; diameter of paddle wheel, 16 feet; width, 18 feet, working 18 feet by 28 inch buckets driven by a set of 10¼ inch by 18 inch, 6 foot compound condensing engines at the rate of 19 to 22 r. p. m., with a tow. She has one Ward water tube boiler type, 20/10, heating surface, 2090 square feet; grate surface 63 square feet. There are 220 4 inch tubes, 10 feet by 2¼ inches long. We have an evaporator, still, and ice machine. The repairs put on the boiler in my three years as chief engineer of this boat consist of the following: Five grate bars, 200 fire brick, two sacks of fire clay, and one set of door liners.

We have the SKF roller bearings on the main shaft and on the crank pins which have never given any trouble.

In the past three years, we have never had a single breakdown in the mechanical end of the steamer.

I believe in 80 per cent to 90 per cent condensed water and the rest fresh water for use in any boiler. I also wish to state that with this boiler we use no induced draft fans. Our condenser has 800 square feet of cooling surface and I have an automatic boiler supply.

One of the other great features in the engine room is 27 inches of vacuum at all times.

This boat was designed by the government engineers and built by The Charles Ward Engineering Works at Charleston, W. Va.

The running hours on this boat are 10 to 16 hours a day. We can run on 90 tons of coal a month which I think is a fair record. Respectfully, William N. Downer, chief engineer, U. S. George S. Nutt.

This write-up in the February 16th issue of the Waterways Journal tells of a three year record on the "George S. Nutt" for SKF and the Charles Ward Engineering Works

SKF INDUSTRIES, INC., 40 East 34th Street, New York, N. Y.

SKF

BALL AND ROLLER BEARINGS

ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

Published by
THE ARMY ORDNANCE ASSOCIATION
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"No great nation in the world, knowing that America has prepared itself for defense, will ever venture to attack it. It is the best insurance against aggression and it is costing the people of the United States almost nothing in its preparation."
Charles B. Robbins, *Former Assistant Secretary of War.*

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Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our Nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

ARMY ORDNANCE ASSOCIATION
The Mills Building, Pennsylvania Ave. at 17th St., N. W.
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The Eleventh Annual Meeting

OF THE

Army Ordnance Association

WILL BE HELD AT

The Aberdeen Proving Ground, Maryland

Thursday, October 10, 1929

THE FOLLOWING ORGANIZATIONS WILL PARTICIPATE:

THE NATIONAL AERONAUTIC ASSOCIATION

AND

THE NATIONAL METAL TRADES ASSOCIATION

THE PROGRAM OF DEMONSTRATIONS, BEGINNING AT 10 O'CLOCK A. M. AND CONTINUING UNTIL 7:30 O'CLOCK P. M., WILL INCLUDE SCIENTIFIC AND TACTICAL EXHIBITIONS OF ORDNANCE, AIRCRAFT AND OTHER ARMY EQUIPMENT

FURTHER ANNOUNCEMENT AS TO THE PROGRAM, SPECIAL TRAINS, REDUCED RAILROAD RATES AND MEALS WILL BE PUBLISHED IN THE SEPTEMBER-OCTOBER ISSUE OF ARMY ORDNANCE

MEMBERS OF THE ARMY ORDNANCE ASSOCIATION AND OF THE PARTICIPATING ORGANIZATIONS WILL RECEIVE PERSONAL INVITATIONS AND COMPLETE DETAILS IN DUE COURSE

Reserve This Date: Thursday, October 10, 1929

ARMY ORDNANCE

VOL. X JULY-AUGUST, 1929 No. 55

The British Armored Forces

What of Our Position as to This New Kind of Warfare?

By Charles G. Mettler*

MECHANICAL power on and behind the battlefield, supplementing the man power in ever increasing quantity, may well describe the modern development of the art of war. The average horse power behind the fighting man in the World War measured the potential force of an army. The industrial capacity of each country to supply power machines to its armies became more and more a deciding factor as the war lasted. In a long war, this capacity will again decide.

But another long war like the last is as unthinkable in Britain as the dissolution of the Empire. The World War took from the political and industrial life of that area millions of young men who should now be the leaders and thinkers and teachers. These were men of the best blood, the men of initiative, of daring and of high purpose, whose loss, now keenly felt, will not be recovered for several generations. The wasted energy of that man-made storm left Europe enervated and listless. Had this been applied to building up the standards of living, happiness and comfort for these crowded millions could have replaced the sorrow and dejection of the last terrible decade. Were the youth who were lost now present as men and leaders, a new era of greatness might be established. Future wars, if they cannot be avoided, must be quick and decisive.

England, the heart and soul of the world's greatest empire, cannot face the possibility of further drain on her man power like the last, nor such a period of extravagant wastage of national resources and energy. If a peace can be conquered quickly, all her ingenuity and resource will strive in her next war to accomplish this result. An as industrial nation, England knows that if she cannot avoid war, her best opportunities lie in the design, production, and use of superfighting machines producible with her industrial equipment, to make available to her on the battlefield the greatest possible useful horsepower per soldier. This is certainly the most advisable position under the conditions which exist in Europe for this anxious and watchful nation to take.

Photopress, London.

An Element of the British Armored Force (Vickers Tanks) on the March Preceded by its Aircraft.

She has carefully considered the value of the new machine. It is an old saying that the deepest wound is made by the quickest, hardest blow with the sharpest point. The greatest energy deliverable with the greatest speed on the narrowest front is accomplished by the modern armored high speed tractor, now so generally called "the tank." At this moment, at least, the tank offers the most direct and accurate application of energy, man-guided to its final duty,

*Former Assistant Military Attaché, American Embassy, London, England. Major, Ordnance Department, U. S. Army.

and offers as well a great amount of energy delivered in advance by its armament. To augment and apply this tank power for battle is one of the principal objects of the British experiment now being completed.

Ever since the British Staff, using the deceptive word "tank," managed to bring upon the battlefield armored tractors, equipped with machine guns and heavier armament to outwit and outfight their opponents, this Staff and nations, too, continue to produce new powerful armored vehicles and train their armies to use them for battle. What should our position be in regard to this new kind of warfare?

FOR the last three years, I have been stationed at the American Embassy in London, as Assistant Military Attaché, watching this new warfare formulate in the British

Photopress, London.

An Element of the British Armored Force at a Halt Protected by Antiaircraft Machine Guns.

its supporters have been thinking, writing, inventing—cross-breeding as it were—adapting and supplementing this armored automotive vehicle for battle purposes. The results of their efforts are now appearing in the armored fighting brigades, wholly mechanized, which have been establishing a new type of warfare and a new war tool on their maneuver grounds.

We are asking ourselves what possible advantage has this new fully armed and armored Goliath, when a naked David, with a modern machine gun, is able to puncture and slay him, when a modern gas field could render him impotent, when our knowledge of mines and bombs gives us the possibility of annihilating him if he approaches our defensive position, when we may pounce upon him from the air and blow him to bits. As we study the ancient practices, we find the individual soldier gradually protected by heavy armor until he could no longer move. He was mounted on horseback and eventually neither he nor his horse could move to advantage, and he was destroyed with his motive power. The world had to abandon his type for war purposes. And on the other hand, the defense has always been equal to the offense in the long run. Human ingenuity has always been as strong in one direction as the other. And yet these persistent British, and many other Army. I have had many friends among the British officers who were intimately connected with this movement. I have marveled at their enthusiasm, seeing two splendid cavalry regiments turn in the highly prized horses for these noisy armored cars; many artillery organizations say farewell to the old favorites and turn gladly to the snorting, roaring dragon tractors; infantry battalions sacrifice their fine maneuvering to scramble aboard clumsy, rumbling trucks, and even slow-moving engineers pile in their balks and boats and disappear in the dust toward the horizon. The one impression that has lasted has been the unbounded confidence of practically every officer in the ultimate success of this new warfare.

When I first arrived, I met some opponents of the tank business, some neutrals, a few luke-warm hopefuls, and a band of noisy converts. Gradually the converts have increased. The neutrals and the luke-warms are the best hymn-singers now and the irreconcilables are few and far between. One officer told me that this too rapid acceptance of the new faith was spoiling its progress. The tank had previously profited so much by the constant argument in the clubs and in the press that now, with the opposition converted, it was difficult to get advertisement. It had become necessary to persuade writers to get on the other side to

keep the attention of Parliament for financial reasons.

When such a conservative group as the British are supposed to be put so much of their precious War Department appropriations into this new warfare, there certainly must be something in it. I believe I can see in it now a marvelous advantage for any industrious and forward-looking nation.

I must confess that my observations of the British work, both its failures and successes, have forced me to get a hymnbook too. If part of my song here below is old music, it is nevertheless quite serious music to me and I am hoping someone will listen to it, taking the effort for its value and forgiving the rendition.

In the first place, history leads us astray on this proposition, for the same reason that history discouraged aviation so long. There has never before existed so much motive power with so little weight. The fact that the soldier became immobile with his added armor was because he could not increase his power plant. Likewise the horse has been limited and the steam engine of later days. The internal combustion engine with fewer and fewer pounds per horse power has allowed us to add more and more armor protection while retaining mobility. This we all know well. We must thank Col. J. F. C. Fuller for original spade work in this field of history and for getting us out of the old way of thinking. Fuller has been the dreamer, opening the way for the more practical followers to build the machines, as is the usual way with thinkers and their successors. He has been followed by many newer writers of more accurate definition, who have had the advantage of the millions of pounds which the British have spent in the field he has indicated. Such names as Broad, Rowan-Robinson, Dening, Burnett-Stuart, Liddell Hart, and others now fill the pages of our magazines.

We may say then that mobility and protection have been combined in spite of the logic of history; not yet and never perhaps adequately, but more so now than ever in the past. And that's enough music about history.

CONSIDERING the problem from the standpoint of battle efficiency, we may say that outside of political or domestic strategy, battles are won or lost through several important local factors inherent in the two opposing organizations. Among them are morale, strategy, tactics and striking energy.

I have mentioned before my great surprise at the increase in the morale of the British Army with the advent of mechanization. Of course, any change, once it is effected, tends to augment the interest for a time or at least arouses curiosity as to its possible advantage, gets the dull man out of his rut and makes him think. Discounting this effect, there remain some more remarkable effects. Here is one. Every ordinary human likes power; enjoys control of something; prefers to see his own will, once exerted, obeyed; and his direction accomplishing something. This is one of the joys of riding on a horse. With the powerful automotive machines, the individual controls greater power; has more independence; is not forced to conform with a multitude of others; is no longer a slave to a line or a form or a time. He drives his engine under his immediate command. The push of a pedal, the turn of a switch, the pressure of a hand, and there is instant obedience. When he arrives, his engine is not tired, demands no immediate care. He can rest his own weary body and when he is refreshed can give his mind to his machine. A Colonel of Artillery at Bulford on Salisbury Plain told me that these factors alone raised the morale of his command a hundredfold when the artillery tractors were introduced.

The Vickers Tanks in Camp. *Photopress, London.*

Here is another effect. A man has greater courage in the presence of power and protection and company. The new machines seem alive to him, responsive and sympathetic. He talks to them, coaxes them, urges them on. He laughs when the armor turns aside a bullet. He has companions in the machine to discuss the situation with, to chaff and to exhort. He works in a little team in friendly rivalry with the teams in other machines. He is out of the mud and the wetness and the cold. He overcomes obstacles that would stop him on foot. He goes into battle without great bodily fatigue, with his mind keen for his task, with his courage high and his power undimmed by his approach, his fight with or his pursuit of his enemy. He learns these things in his maneuvers. And if the machine fails, well, his mind is diverted from his danger in reviving his machine.

When a great mass of tanks advance, there is a consciousness of tremendous, irresistible power, with which the morale goes high.

There is something in this morale business which must not be overlooked.

On the strategical side, we are all well aware of the advantages of the greater mobility. It permits us to arrive first, to choose the battlefield, to prepare defensive measures until the time for offense arrives. At the beginning of war, the seizure of strategical points may be hastened before the enemy, without a mechanized mobile force, can determine our objective or take steps to deter us. A mechanized force, in being, should shorten the war for the side which has it.

On the tactical side, we are not in ignorance of the uses of greater mobility. The flanks are at the mercy of a more mobile enemy. The communications are in danger. The point of attack is not evident so soon. The time of approach is so short, we cannot rest in our defenses. The artillery bombardment may not be required. The barbed wire is of little value. The defensive trench must be of great width, which we cannot dig quickly. Our machine guns must be emplaced, which cannot be done in a hurry. The mines must be brought up and planted. If we are not mechanized, the ammunition may be late. Unless we are long in position, the defense is not so easy. The mobility and the armor protection should be on our side.

I can imagine no more unfortunate predicament for a military commander than the task of conducting a division through a territory in which an armored brigade is known to be operating. If that brigade should be discovered ten miles from his flank, he would not know at what moment it might strike. If it turned in his direction, it would in twenty minutes be upon his train or his advance guard or breaking directly toward his extended center. He would have to halt to repel the attack and suffer endless confusion and delay. The armored group would quickly play what havoc it could and withdraw out of his range. No sooner had he resumed his march position than it would be upon him again. Yet with his slow moving organization, he could not pursue nor detach a small unit to follow such a powerful enemy without risking the loss of the unit.

Photopress, London.

The Radio Control Center in Operation on Salisbury Plain.

The tactical possibilities of such an armored force, once well in hand, in good training, are tremendous. Of course, there would be losses, but think of the possibilities.

When we have concluded the strategical moves, have completed the final tactical maneuvers on the field and are ready to close for the final struggle, the energy with which we may strike is the final consideration.

The actual striking force which an army delivers upon its enemy in attack may be summed up mathematically in the expression which we learned in Physics "A," $mv^2/2$. In this "m" is the striking mass; "v" is its average striking speed. It is evident that an increase in the "v" gives us an enormous increase in our delivered stroke.

This factor we may subdivide into the ammunition force and the army force.

$mv^2/2 = m^1v^{12} + m^{11}v^{11-2}/2$, in which

m^1 = the ammunition expended

v^1 = its velocity

m^{11} = the army strength in men and machines

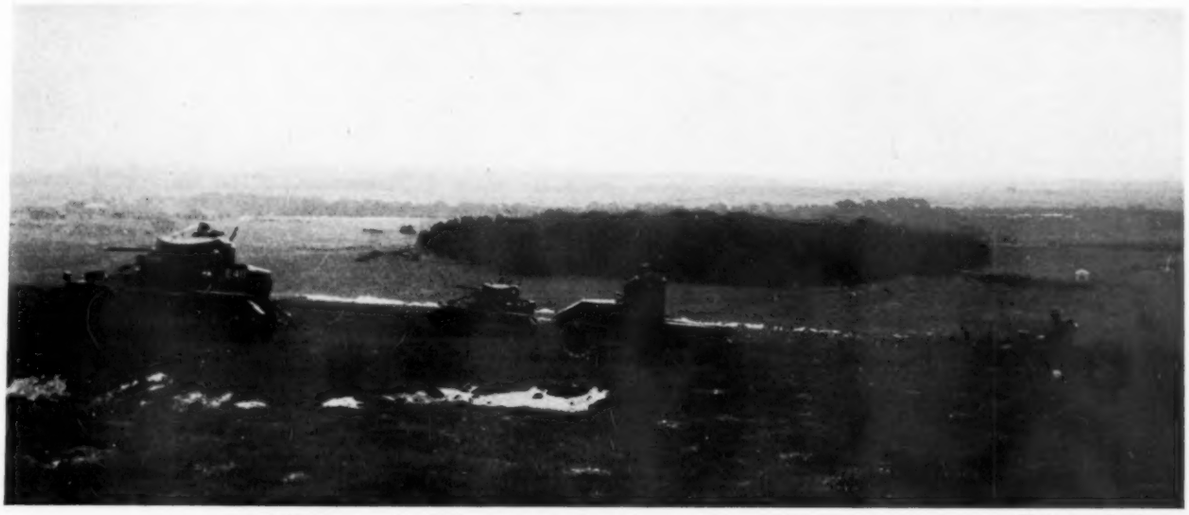
v^{11} = the speed of army advance.

Of course, we have neglected some small modifying factors, but these can be disregarded for the general case. We note some advantage in having powerful fire arms.

Now let us add coëfficients to our factors to get down to actual effectiveness. Let "a" represent percentage of the shots which are hitting where they give us an advantage. And "b" represent the percentage of our army which actually arrives on the contact line. Then—

$$mv^2/2 = am^1v^{12} + bm^{11}v^{11-2}/2$$

As our old friend Professor C. Smith used to say in his memorable books, "it can be plainly shewn" that an



A Little Fellow Accompanying the Big Ones for Reconnoitering Purposes. *Photopress, London.*

advantage can be gained in increasing "a" by providing the best protection for our gunners, the most stable platform from which they may fire and the best fire-control apparatus to direct their aim. Our designers can help with these factors in the construction of the armored vehicle. And then, the gunners can be trained to fire fairly accurately from moving vehicles as the British have repeatedly proved in their Tank Gunnery School at Lulworth Cove.

"It can also be shewn" that adequate armor protection, carefully planned as to location on the machines, proper spacing of the vehicles in the advance, proper training of drivers to take full advantage of their speed and the accidents of terrain, all these factors can be "shewn" to increase the "b" coëfficient enormously. The advantages of fine driving and fine control have been proved at the Tank Drivers' and Tank Tactics Schools on Salisbury Plain.

The a's and the m's and the v's are the joint responsibility of the teachers and the trainers, as well as of the designers and the maintainers. Neither dare shirk the final responsibility. The question of track life, track noise, track dependability, engine life, engine reliability, silence, ground clearance, trench-crossing ability, flotation, speeds, direction control, navigation, vision from within, gas protection, height, road space, shipping space, strain on bridges, and a thousand and one other items of specification are the results of compromise between the engineer and the tactician. It is essential that they work in the closest coöperation. The British have arranged to accomplish these compromises in their Mechanical Warfare Committee in the War Office.

When the engineer has finished his design, and the manufacturer has produced his best product from the design, the machine becomes the property and working tool of the tank officer. This latter operator must understand the capabilities and limitations of his tool, its peculiarities, its tricks of manipulation, and the terrain on which it will perform its worst and its best. Then he may give the designer and the producer new specifications to work on when they return to their offices. The British Experimental Establishment, or Proving Ground, at Farnborough is the meeting place where the workouts are performed; where the forces meet; where modifications and new designs are thought out.

In all these places, the "a" and the "b" and the "v" factors are carefully considered in their proper atmospheres.

Once having worked out the vehicle itself to its best value for the time being, it becomes necessary to find out how to use it in the army, to supplement, protect and supply it in the field, to command and control it in great masses, to organize its groups for effective operation as units and to determine how it would be used in strategy and tactics. Something more than a few experimental vehicles is required to acquire such information.

IT takes nerve to spend millions on an idea. Unless there is abundant confidence in it, capital is not usually forthcoming. The British have boldly spent their millions, not only for their research but for their production too; not only for the tanks but for all the adjuncts and accessories to go with them; not only for the automotive vehicles, but for the communications, the supply, the armament in support, and the bridge trains to carry them over water. They have set up a complete tactical experimental station, made up a complete armored force and tried out the various means of using such a force, organizing it, commanding it and standardizing its drill and maneuver. For two years of constant study, cutting and trying, they have arrived at an armored brigade within a mechanized division. Here will be tried out the value of the small tank operating directly with the infantry. So far, this seems to be a temporary solution. This is not enough experience for final standardization of the new warfare. There are now organized two divisions with armored brigades within them, one at Aldershot, another at Salisbury, adjacent commands. These will operate to determine the best arrangements for complete organizations and will perhaps eventually contend with each other to furnish new data for further improvement in organization and matériel. No doubt there will be new trials of the independent armored brigade when better equipment is available.

When all this new machinery was in a state of design and manufacture, it was found that the responsibility for its performances in one unit in the field rested in several departments in the War Office. Its supply, modification and maintenance depended upon various branches whose ideas did not always coincide, whose funds were not always

applicable, whose facilities were not always adequate and whose little prejudices and jealousies interfered with steady progress and full accomplishment. Along with the field reorganization, the central authority was also reorganized. The new fighting matériel was placed under one responsible head, who designed, produced and maintained it, and who was represented in the field by one proper deputy. Reorganization in the field caused by the new warfare, made necessary reorganization in the central offices to secure the efficiency desired.

They have now reached the end of the first period of experiment, standardization, rearmament, and reorganization. There remains to be accomplished the further extension of the organization, the development of indicated matériel, and the numerous minor changes in perfecting the scheme. The next move will no doubt be the establishment of independent armored forces in England, Egypt and India, as new working tools of the military forces.

Photopress, London.

The British Two-man Tanks on the March.

In the meantime, the first part of the new cycle has begun, experimentation with newer types of tanks, armored cars, bridge material, communication and auxiliary equipment. Unless the rest of the world catches up, there will be time enough for the building of new standards in England, but the designs for new standards will be ready when this time comes. There is no more sleep for the defenders of England. In the meantime, however, the satisfaction of having in being a new system of warfare with its equipment and its organization, and behind it a marvelous enthusiasm of personnel, is their reward for ten years of hard labor and study, heavy expenditure of funds and much argument. There is now a certain feeling of military safety with the small regular army which has not always existed in this snug little island.

THERE are many details of British design, British practice and British thought for the future, which are written in this hymnbook of mine. I will not try to sing all the music at my initial recital.

I merely want at this moment to introduce you to the armored force itself, moving toward us over the open terrain on its mission of seeking its enemy; coming in some such manner as the British Armored Force appeared before King Amanullah of Afghanistan on Salisbury Plain last summer, expanded here and there to cover contemplated equipment not yet supplied.

Already over the horizon come the scout planes, flying low to see as much of the terrain as possible; the high ones in rear are attack planes to drive off enemy planes or assist in the ground attack if one develops. They are speaking by radio to the force commander.

Along the roads to the right and left come the five to seven ton armored cars, replacing the cavalry for this particular task, with the little half to three-quarter ton scout cars as aides to investigate special places, or run off to warn or guide the supporting columns. The armored cars run quickly to bridges and crossings, hold them for a while till they are sure they are safe, then rush ahead by twos or threes to a new point of vantage. If they are held up by resistance, their commander may advise the force commander by radio or the scouts bring help from the rear or the flanks, and out goes the resistance. If it be too strong, never mind, the tankettes are close behind. They take up the task and the armored cars go on around the resistance to find the stouter line of opposition in rear. The advance commander may eventually call the (five to seven ton) tanks from a flank patrol to help the tankettes, but light patrols do not hold the tankettes long. The movement resumes its usual speed.

On come the machine gun carriers, ready to unload their packages of fighting equipment to hold a bridge, to defend the exit of a defile, to hold a local hilltop for a while, or to do ground work upon a stubborn grove or copse where the armored vehicles cannot enter.

The heavy twelve to fifteen ton fighters form the nucleus of this mass of moving power, following the roads, the low places, behind the wooded stretches, waiting at times until the advance ground is cleared, biding their time for the great stroke when their weight and armament are needed to turn the battle, but always keeping the speed of march. With them are the self-propelled artillery mounts and their ammunition wagons.

The progress is rapid. Fifteen miles an hour is ordinary running on the level stretches. Twelve miles an hour is almost average for hill and dale country. The whole force is past us in a few minutes.

Then comes perhaps the light supply train. Gasoline and oil tank wagons, supply trucks, machine shop trucks, bridging material, and similar required auxiliaries to keep the force in continuous movement.

Perhaps behind the train a small rear guard and flank guard of tankettes and a few cruisers. A scout airplane sails back over the flanks and rear now and then to discover any hostile movement. There is always a chance for some concealed force to come out, some other fast moving armored force to cut in after the main group has gone by. Then the independent armored force is gone on its mission.

The divisions with the columns follow at a long distance. On the roads come the mechanized brigades, their trucks in groups under their commanders, who are in scout cars or standard automobiles, equipped for cross-country going.

These are heavy trucks, three to five tons, six-wheeled cross-country variety, with seats for all the soldiers. The men have a long ride before them. When the columns halt, they are out for exercise or perhaps for drill to simulate their future work. Perhaps all brigades of the division may be carried thus.

Then the division trains and the rear guard again.

May we picture this fast free armored unit taking the brunt of a battle. With the speed it has acquired, it should find its enemy on the march, but if he has reached his defensive position and has prepared it, there can be no delay in finding his most vulnerable point, his numerical strength and the strength of his defense. The armored cars circle his flanks and try to gain his rear. The airplanes search his supports and reserves to prevent their participation, or to advise of their movements. The light tanks and cruisers go in under the holding fire of the heavy tanks and self-propelled artillery to try out the selected point for attack. They cover the approach rapidly to get among his troops where his artillery dare not fire. The heavy tanks watch under as much protection from artillery fire as possible and use their covering fire. At the proper moment, they take full speed, firing as they go to drive home the attack. The machine gun carriers follow in to hold their positions. If there is a break, the mechanized brigades follow to consolidate and maintain the position. A defense is organized and the armored force draws off out of artillery fire. Can it be done? Even if it fail, the damage done, the confusion created in the enemy's position, the opening of his defenses is something accomplished. The way is prepared for other tools.

We might picture this force in counter-attack, in exploiting the retreat of the enemy, in protecting our own retreat if need be. Here are many phases where the new supertool may be used effectively.

ONE must not be confused with the multiplicity of this equipment or its extended organization. The days of simplicity are over. A tool for each kind of job is the order of the day. We don't do everything in a machine shop on a lathe any more. The variety of tools equals the variety of kinds of work we have to do. Work can be performed far better by the most suitable tool for the job. We don't try to cut the lawn with a combination harvester, nor try to gather the grain with a lawn mower. Yet each job was one time done with the scythe.

In war, as in every other business, the proper tool for the job is likely to get the job done more neatly and with greater dispatch. The doughboy on foot alone is probably still the best tool for getting and bringing information in the night from the other side of No Man's Land, and his best tool for the job may still be his trench knife, the most primitive weapon. The best troops for wooded, mountainous country may still be the mounted cavalry. The best holding force for captured positions is the foot soldiers properly intrenched. The best weapon for tearing down prepared positions may still be the heavy howitzer. There remains much work for the light field artillery, the pack artillery, the long range railway artillery, and the newer antiaircraft artillery.

But after all, the force which takes the open battlefield, holds it and pursues the enemy to drive him from the open country where people dwell and grow their food, that force wins the battle and in the end should conquer a peace. Most of the great decisive battles of the world have been fought in the open country where troops could be handled, where the homeland lay which the people loved and desired to retain. The most efficient tool for this open country battle has not yet been forged, I grant you, but in the armored force there is being built a better tool than was ever made before. An expensive tool to be sure, but one which is fitted for the work, one which we of all people can afford to make, one which may in the end, by its very presence, save us war, and if war comes will save us endless time and loss of the precious youth which has fallen so often in the long wars to set back the hands of civilization's clock by centuries.

British Armored Cars in the Police Commissioner's Compound, Bombay, India.

Ammunition for Small Arms

With Particular Reference to the Cal. .30 M 1 Cartridge

By W. E. Witsil*

SINCE the World War considerable prominence has been given to certain new and spectacular branches of the service. These have appealed to the imagination of the average layman and may have given him a false impression of the military value of the auxiliary services. In the last analysis, and without disparaging or minimizing the importance of such branches of the service as chemical warfare, aviation for reconnaissance or demolition, trench warfare matériel and long range artillery, it must be considered as fundamental that without the infantry the enemy's position cannot be occupied and that it is the function of the infantry to complete the engagement and consolidate the position.

The Caliber .30 M 1 Bullet.

The tactical superiority of the infantry combat unit depends on a preponderance of fire properly placed. Modern warfare demands even more from the weapons of the infantryman than ever before. The machine gun barrage, machine gun enfilade, direct and cross fire, antiaircraft protection, and the rifle or pistol of the individual soldier and officer all require an adequate and continuous supply of ammunition. This then becomes the point of contact between the Ordnance Department and the combat arm, and from this point of contact the line is traced back through the ammunition train, the ammunition dump, the reserve depot, the storage arsenal and thence to the manufacturer.

In time of peace it is necessary to maintain an adequate war reserve commensurate with the war plans of the General Staff. In connection with these war plans manufacturers of small arms ammunition may well be proud that they represent an industry which, to a material extent, is in constant readiness for an emergency.

THE manufacture of the service cartridge in some respects is similar to the manufacture of ammunition for the modern high velocity sporting rifle. We might consider briefly the different classifications of sporting ammunition and their relation to ammunition required for military purposes. Small arms ammunition is generally divided into the three following classes: (a) rim-fire cartridges; (b) center-fire metallic cartridges (for revolvers, pistols and rifles); and (c) shot shells.

Rim-fire ammunition includes the small bore cartridges used in galleries, small bore tournaments, indoor rifle range practice, etc., the more popular sizes being .22 short, .22 long and .22 long rifle. Other miscellaneous rim-fire cartridges are still supplied, although not in very great volume, such as caliber .25, .32, .38, .41 and .44. The rim-fire cartridge is one in which the shell and primer are in one piece and headed in such a manner as to leave a cavity in the rim. This cavity is filled with wet priming composition and then dried. The powder charge established for the desired ballistics is loaded, usually by the plate loading method. The bullets, usually of lead, are then seated and the mouth of the cartridge is turned over into the bullet to hold it in place. This operation is usually referred to as the "crimp" or fastening operation. Enormous quantities of these small sizes of rim-fire ammunition are consumed each year.

From the military standpoint it is of interest to point out that the standard small bore rifle for the United States Army is now known as the "U. S. Rifle Caliber .22 Model 1922 MI." This is a bolt-action rifle made at Springfield Armory and has become so popular that it is used in practically all of the small bore matches, together with the other popular commercial makes of caliber .22 target rifles. The use of this rifle naturally requires the procurement of .22 long rifle ammunition for training purposes, as well as for the targetting of rifles at Springfield Armory. To this end definite specifications have been prepared by the Ordnance Department covering the manufacture, inspection and test of .22 long rifle ammunition. Some of the ammunition procured on these contracts has been of the semismokeless, or Lesmok, variety, but more recently preference has been expressed for the more modern noncorrosive ammunition loaded with smokeless powder, the specifications having been revised to include this requirement. It is understood that the accuracy of certain lots of this .22 long rifle noncorrosive ammunition has been so remarkable as to call for special comment.

Center-fire metallic ammunition for sporting purposes has been very definitely improved in the last thirty years. Many important changes in design and in manufacturing methods have taken place during this period of time. In one of the prominent journals devoted to news of interest

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to dealers in sporting goods there recently appeared an article, in which the author expressed some discouragement at the fact that improvements made in the design of firearms and ammunition in the last thirty years had not been very remarkable, although in the same article a very complete list of accomplishments was recited, all of which were summarized in the statement that "we have seen new and improved models but not much change." While admitting that the changes have not been spectacular since the days of the Krag rifle, the modern cartridge embodies improvements and refinements in design and methods of manufacturing control which were not known in the days of '98. The ammunition industry has advanced with other industries in modern methods of production, and scientific control of materials and methods of test. It may be that we have followed the slogan "constant improvements, but no yearly models," but the improvements have been made nevertheless, as I will point out later.

The Caliber .50 Armor-piercing Cartridge Contrasted with the Caliber .30 M 1 Ammunition.

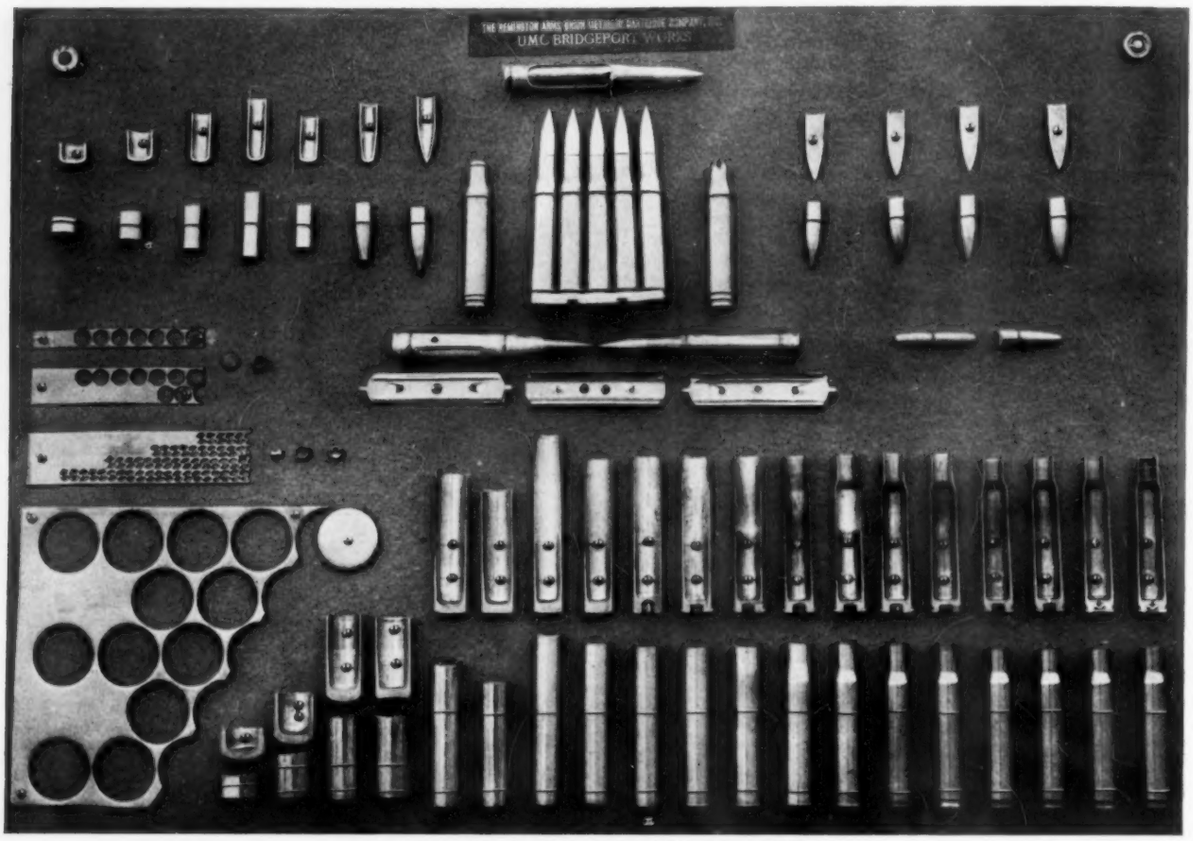
The manufacture of center-fire metallic sporting cartridges permits the production of peace-time and war reserve requirements of the present service cartridge for the caliber .30 Springfield rifle, as well as the caliber .45 automatic pistol cartridge for use in the service side-arm—the .45 Colt automatic pistol, and the .45 Thompson submachine gun used by the Marines in Nicaragua. Mention should be made, also, of the caliber .50 cartridge principally used as antiaircraft protection in the caliber .50 Browning machine gun.

The manufacture of paper shot shells for sporting purposes represents the most important, from the standpoint of volume of production, of the three classes of ammunition made by the commercial ammunition manufacturers. While directly considered, the shot shell in itself is not a cartridge of major military importance, nevertheless specifications have been prepared covering the manufacture of shot shells for use in riot guns sometimes supplied to troops on special duty, as well as trap and field loads for training purposes. These shells are standard loads regularly made and sold by the ammunition companies.

It will thus be seen that the peace-time requirements of the Army can be met by the private manufacturers, and, in the case of the rim-fire cartridges and paper shot shells, only the private manufacturers are in a position to make deliveries. The Ordnance Department of the United States Army appreciates this fact and favorable comment has been made on the World War production record of the American ammunition manufacturers of small arms and ammunition, particularly caliber .30 Springfield and .45 automatic pistol cartridges. The Honorable Benedict Crowell, Assistant Secretary of War and Director of Munitions during the war, in the official publication entitled "America's Munitions 1917-1918," states that during the World War American ammunition manufacturers produced 2,143,039,900 of these military cartridges and that the Government arsenals produced 89,088,500, or only 4 per cent of the total. The capacity of the ammunition manufacturers during the war was increased from an estimated figure of one hundred million per year to practically two billion per year. This ammunition would not have been produced in such a short time except for the private manufacturers. In other words, private manufacturers made over 95 per cent of the total of the small arms ammunition which was used in the last war.

This was remarked upon, also, by Lieut. Col. Townsend Whelen, Ordnance Department, United States Army, before the Ways and Means Committee of the House of Representatives in January, 1929. Colonel Whelen called attention to the importance of this industry to the national defense and emphasized the fact that without the private manufacturers it would be necessary to increase the reserve to the extent of $117,000,000 worth of small arms ammunition, or else create a plant that would be kept in a constant stand-by condition, at a cost of about $30,000,000. It is interesting, also, to note that with the exception of small arms and ammunition our troops fought the war with munitions obtained abroad, because there was not time available to make such ammunition in this country.

AT this point it would seem appropriate to consider some of the items of interest in the development of the present service cartridge, known as caliber .30 M 1. Looking back to the first change made in the brass shell itself, we find that in 1903 the service cartridge was changed from the .30-40 Krag, model of 1898, which was made with a rim, and a powder capacity about the same as the .303 British, to a cartridge very much like the 8-mm. Mauser, made without a rim and with a larger powder capacity than the Krag or the Mauser. The caliber was retained at .30 and at first the Krag bullet weight of 220 grains was continued with the caliber .30, model 1903, cartridge.



Caliber .30 Springfield Model 1906 Ammunition.

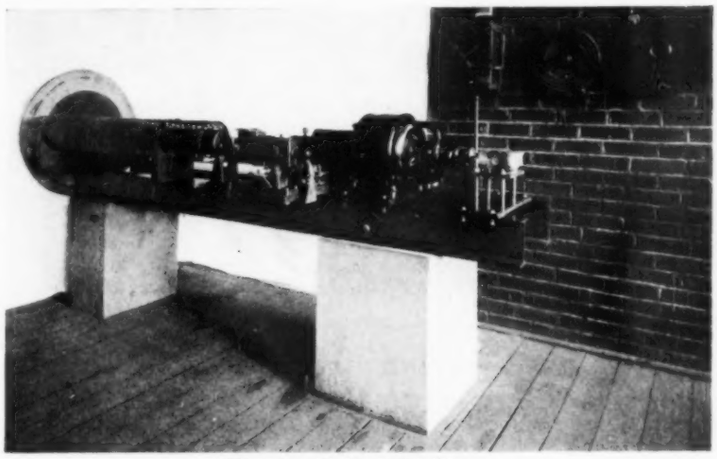
In 1906 a change was made to modernize the cartridge, to use the lighter high velocity bullet with the sharp point. Rifles were rechambered to take this cartridge and were designated by the cumbersome term ".30 Caliber Model 1903 Springfield chambered for 1906 ammunition." This cartridge with the 150 grain pointed flat-base bullet and a muzzle velocity of 2,700 f. s. remained as the standard service cartridge of the United States Army from 1906 until 1926. In other words, twenty years elapsed before any other essential change took place.

As the result of some of the observations made during the war, tests were undertaken some time after the Armistice to determine the ranging qualities of various types of bullets and ammunition. These tests were made at Daytona Beach, Florida, where facilities were available for long-range firing and observation. As the result of these tests and of the general consideration of improvement in design, a change was proposed in which the weight of the bullet would be increased to about 172 grains and that the heel would be tapered at whichever angle was found to be suitable. The first change contemplated a taper of 6°. This was later changed to 9°, which is the standard at the present time. It was proposed that by the use of special powder the muzzle velocity of the new bullet would be established at 2,700 f. s., or the same as the caliber .30, model 1906, 150 grain flat-base pointed. With this muzzle velocity a substantial improvement in ranging qualities was expected.

According to figures contained in an article by Maj. Glenn P. Wilhelm in ARMY ORDNANCE, March-April, 1925, the maximum horizontal range of the new service ammunition is 6,000 yards as compared with the .30-'06 of 3,400 yards, or about 3½ miles compared with a little under 2 miles. At ordinary hunting and military ranges up to 1,000 yards there is no material advantage in the boat-tail bullet aside from striking energy. The flatness of trajectory at these ranges is not such as to matter materially, although for long-range machine gun barrage fire the caliber .30 M 1 cartridge will doubtless be a distinct improvement. It might be mentioned here incidentally that the stream-line, or boat-tail, bullet was not an original idea of our Ordnance Department. One of the earliest adaptations of this principle to a military cartridge is the 8-mm. French Lebel solid bronze bullet, weighing 198 grains, known as the "Model 1886." This cartridge, however, has a muzzle velocity of only 2,400 f. s., because of the heavy bullet.

The development of 1925 resulted in the production of National Match ammunition by Frankford Arsenal, the accuracy of which was so satisfactory as to win the competition for Frankford Arsenal for the first time against three of the commercial manufacturers. This accomplishment with a new design was considered quite remarkable. The powder used at that time was a special type of progressive burning nitrocellulose powder, known as "DuPont I. M. R. 1147." The Palma Match cartridge, however, had an instrumental velocity at 78 feet of 2,776 f. s., and developed pressures higher than would be considered satisfactory for a service cartridge. The Frankford Arsenal cartridge submitted for International Matches at 300 meters contained a charge of DuPont 1195 powder, giving an instrumental velocity of only 2,207 f. s., which was thought to be sufficient for the 300 meter range.

Following the successful performance in 1925 of the Frankford Arsenal Match ammunition for the Palma and International matches, tentative specifications were prepared for the consideration of Frankford Arsenal and the private manufacturers, with a view to adapting the 1925 design to production, and specifically to obtain from the manufacturers expression of opinion, which would make it possible to prepare specifications sufficiently workable for large scale manufacture. These specifications were submitted in April, 1926, bearing the official number 50-1-17. Revisions have been made from time to time leading up to contracts placed in the latter part of 1926. The knowledge gained from the small contracts placed at that time permitted still further revision preparatory to the placing of other contracts in 1927. All the ammunition contracted for was ammunition "for use other than aireraft," as the specifications for aireraft ammunition require 100 per cent inspection and the real objective of the Ordnance Department was to determine whether or not the commercial manufacturers could be relied upon to produce the caliber .30 M 1 cartridge in satisfactory volume for emergency use.



Hangfire Testing Machine.
Apparatus for determining ignition by detecting hangfires occurring in machine-gun firing.

It was found during the ballistic testing on these contracts that the relation between velocity and pressure was such that a very small margin of safety was available, so in order to permit easier loading conditions the specifications were modified to permit a reduction in velocity of 40 f. s.

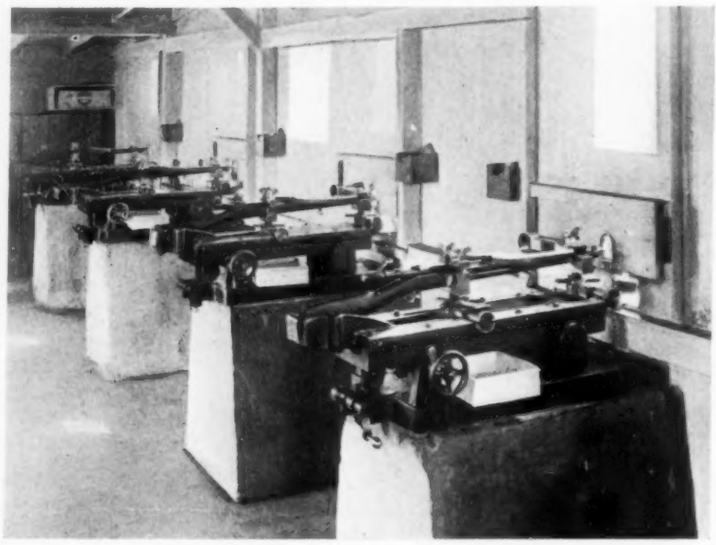
The company with which I am associated in a civilian capacity produced 500,000 cartridges on a contract completed in June, 1927, and 10,000,000 cartridges on a second contract completed in October, 1928. Experience gained in this production has resulted in consideration being given to a possible change in the limits required in the specification covering drop tests of primed shells, with special reference to the low drop, as it is believed this requirement would be difficult to meet in war-time production. It is possible that the accuracy specification could be modified slightly to permit a little wider tolerance, although the accuracy of ammunition made on the contracts above mentioned has been satisfactory and the requirements have been met without any special difficulty. Other tests which are of special interest in these specifications are the hangfire tests, the machine gun tests, the bolt-pull test and the mercury cracking test. The latter test is a new development intended to discover defects in the brass or the anneal which will tend toward "season cracks." Careful attention has been given to the allowable inspection and casualty defects and it is believed that the manufacturers can comply without serious difficulty.

THERE is still some question as to the advantage, from the standpoint of ammunition supply, of the caliber .30 M 1 cartridge, in view of the special machinery required for the manufacture of the boat-tail bullet. It is understood that certain straight-line machines specially designed for the manufacture of these bullets have already been tried out by Frankford Arsenal and one or two of the ammunition manufacturers, while other manufacturers have adapted their regular presses to the operations necessary to completely assemble the bullet. The average capacity of the straight-line machine is about twenty to twenty-five thousand bullets per day. To obtain approximately this same production on regular bullet assembling machines of the dial type three machines would be necessary for the manufacture of the 172-grain boat-tail bullet, as compared with one machine of the dial type, used in the manufacture of the same number of 150-grain flat-base service bullets. In other words, it is either necessary to purchase sufficient new straight-line machines for the anticipated war-time requirements of the Army, which would be a very expensive proposition, or to consider that three machines of the standard type will be required for each individual machine previously needed. Consequently, only one-third of the number of 172 grain boat-tail bullets can be produced from a given number of machines that were formerly making the 150 grain pointed flat-base bullet. This situation should receive careful consideration as to its influence on war plans.

The powder used in the caliber .30 M 1 cartridge is a special powder, known as DuPont I. M. R. No. 1185. This is a nitrocellulose powder of high nitration, surface treated, approximately in the same manner as the other I. M. R. powders, in order to obtain the velocity desired within the limits of pressure. I have already mentioned, however, that the margin of pressure was too narrow for smooth working conditions and a reduction in velocity was granted, which afforded considerable relief from the ballistic standpoint. There has been some doubt expressed as to the ease of ignition of No. 1185 powder in conjunction with primers heretofore used successfully with other powders for sporting, military and match ammunition. Obviously, the most desirable combination would be a powder which can be readily ignited by a standard primer.

Some of the proposals covering the purchase of caliber .30 M 1 ammunition have provided that the powder will be furnished by the United States; others have required the contractor to obtain powder from the powder manufacturer. Some preference has been expressed for the latter method, which enables the ammunition manufacturer to communicate directly with the powder manufacturer concerning questions of ballistics and delivery.

THE method of taking pressures is one that has for years been the subject of discussion. One school believes it preferable to use copper cylinders that have been precompressed to a certain decrement slightly less than the reduction expected from the anticipated pressure, and another school thinks that the best results are obtained by the use of uncompressed coppers. The use of uncompressed coppers is now acceptable to the Ordnance Department.



Machine Rests for Accuracy Testing.

Important experience has been gained during these trial orders from the contacts between the inspector and the contractor. Methods of inspection have been worked out, standardized and simplified. Intelligent and thorough inspection is an essential in which the contractor is interested, as well as the purchaser. By working together both parties can assist materially in making sure that only ammunition of satisfactory quality will be obtained by the United States.

It might be mentioned here that the bill which has been recently introduced in Congress to permit the placing of educational orders should be an important step in keeping contractors interested in the manufacture of Ordnance matériel. Actual production brings out problems that cannot be foreseen by academic consideration of specifications and contract terms. Cost data can be compiled from experience and improved methods of manufacture and handling can be developed, which will be invaluable in time of emergency.

Both Maj. Gen. C. C. Williams, Chief of Ordnance, and Brig. Gen. C. L'H. Ruggles, Assistant to the Chief of Ordnance, favor the idea of interesting commercial manufacturers in the production of small arms ammunition. Credit should, also, be given to Lieut. Col. Townsend Whelen, the late Maj. Lee O. Wright and Maj. W. L. Clay, at present assistant to the Chief of Ordnance in charge of infantry and aircraft armament, also, Maj. Glenn P. Wilhelm and Maj. Julian S. Hatcher and the other officers who have been interested in the design and development of the caliber .30 M 1 cartridge.

While the caliber .30 M 1 cartridge is still in its infancy, we are already anticipating the birth of a new military cartridge, concerning which some publicity has already appeared. The proposed cartridge is to be of smaller caliber than .30 and lighter in weight, to meet the conditions of certain types of automatic rifles that are being developed by the Ordnance Department. Definite specifications have not yet been prepared, as this cartridge is still considered experimental.

Other subjects of general interest that should be mentioned are improvements in tracer, incendiary, and armor-piercing cartridges, the development of noncorrosive primers, and improvements in powders for use with them; and the development of flashless nonhygroscopic smokeless powder for the caliber .30 M 1 cartridge.

Research, invention and scientific investigation are necessary to assure the growth, and sometimes even the existence, of a modern industrial enterprise. These are equally essential to the military establishment. By combining the manufacturing and technical experience of the commercial manufacturer and the facilities and opportunities for research of the several divisions of the Ordnance Department, there is every reason to expect that improvement and progress will be assured and that the armed forces of the United States will be supplied with small arms ammunition which will be equal, if not superior, to the ammunition of any other country in the world.

14-Inch Railway Gun to Cross Continent

THE second of the Army's largest railway guns and mounts will start a transcontinental journey about July 1. It is the latest 14-inch gun, weighing with railway mount 730,000 pounds. The rifle was built at Watervliet Arsenal, New York, and the mount at Watertown Arsenal, Massachusetts. It is now at Aberdeen Proving Ground.

The gun will be emplaced at the Presidio of San Francisco, Calif., and, together with a smaller gun, which was transported to Fort MacArthur, near San Diego, Calif., several years ago, will form an important part of the seacoast defenses of the Pacific Coast.

Capt. Archibald S. Parmelee, Coast Artillery Corps, now on duty at the University of Pittsburgh, has been designated to take charge of and accompany the gun to the Presidio of San Francisco.

The great weight of the gun, which with its mount is heavier than the largest locomotive ever built, demands extreme care in its transportation. Advantage will be taken of the opportunity presented by this journey to determine the performance of the matériel on such a long journey over a variety of trackage, the manner in which our railroads handle such a shipment and whether such an enormous shipment can be made without delay on account of condition of tracks, tunnels, bridges, grades and curves.

The railroad routing decided upon calls for transportation from Aberdeen, Md., to Chicago via Pennsylvania Railroad; Chicago and North Western Railway from Chicago to Council Bluffs, Iowa; Union Pacific System from Council Bluffs to Ogden, and Southern Pacific Lines from Ogden to destination.

Mechanization and Military History

Will the New Matériel Put an End to Conscript Armies?

By Hoffman Nickerson*

ALL military effort is conditioned first by the type of recruitment, ranging from the long service professional army to the most temporary of improvised forces, and by the weapons and equipment available. At the present time mechanization, i. e., the combination of automatic weapons with the internal combustion engine and the caterpillar tractor, shows at least the possibility of changes in tactics and strategy so far-reaching as to involve a change in the type of recruitment, that is the prevailing type of modern armies. Basing itself on General Williams' interesting article in the March-April number of ARMY ORDNANCE, the present paper will suggest certain contributions military history might make not only to the discussion of mechanization itself but also to the underlying problem of military policy.

History is the record of past experiment. To appreciate its importance to military thought it is necessary only to imagine an experimental science compelled to estimate numbers of new factors while forbidden all full laboratory tests except during short and irregularly spaced periods of time corresponding to wars. Obviously such a science, while actively pushing such incomplete tests (corresponding to peace-time maneuvers) as were immediately possible, would find itself forced back upon minute study of the results obtained during former intervals of full experiment. Particularly the results obtained from such of the old forces as most resembled the new and largely unknown factors would have to be worked over. While the method of relying upon past experiments has grave limitations yet peace-time military science can find no other. Hence it is not surprising to learn that the first Von Moltke used to put his ablest general staff officers into the Historical Section.

Obviously the past experiment nearest to future mechanization is the tank of 1916-18. The outlines of the matter are familiar: the enormous strength of the modern defensive against frontal attack and the demonstrated power of the new offensive weapon. The spectacle of tank squadrons stamping out the nested machine guns that had riddled every offensive on the western front was enough to strike the imagination of every soldier.

The first thing then to be done is to obtain a record at the same time as broad and as precise as possible of the tank operations of the World War. Breadth could be had by collecting the opinions of as many as possible of the officers who took part in operations in which tanks played a part. The general opinion of the average officer who had seen tanks in action as to the value of the contribution made by them would be important and that of men of known military judgment would still be more so. Precision of course could not be had in all cases; it would be most desirable however to achieve it wherever possible. Especially it would be well to see if a ratio could be established between the number of field guns available for the defense of a sector and the number of attacking tanks disabled by their fire—in proportion, of course, to the number of tanks making the attack. The numbers of tanks disabled by weapons other than the field gun, clusters of grenades, antitank rifles, flame projectors, land mines, etc., should also be studied. Also some data as to the power of the war-time tank to cope with different sorts of obstacles, deep water, a steep bank, etc., should be had and some idea of how long it must have taken the Germans to prepare such obstacles where they did not already exist.

STARTING then from a broad general judgment as to the value of the tank in the recent war supplemented by all available precise information on particular tank operations, it would then be possible to make some estimate of the probable value of tanks in future operations. To the known or at least reasonably well known facts of 1916-18, particularly 1918, could be added the ratio of improvement in tanks versus that in antitank weapons. At a guess it seems probable that the improvement in tanks would be found much greater than that in antitank devices. Thus the split trail for the light field gun gives the latter a wider traverse and therefore a wider lateral field of fire (45° as against 6° for the war-time single-trail mount), but on the other hand this is far more than counterbalanced by the increased speed of today's tanks, 15 to 20 miles an hour (so General Williams has told us) as against a maximum 1918 speed of five miles an hour, and even this reduced in practice by 1918 tank tactics to a speed no greater than that of the advancing infantry. Even if improved field gun sights for firing at moving objects, based either upon antiaircraft sights or upon some variant of naval fire-control devices could be worked out, it would still seem that the balance of 1918 would be tilted heavily in favor of the tank. Whatever increased ability the new machines have in dealing with obstacles must also count for them.

Still another element in the calculation, less obvious than the foregoing and certainly far more difficult to estimate closely, would be the density of population in the probable theaters of war. Obviously a thickly populated region may be able to maintain and provide communications for armies so large that they can entrench and man a front extending across the entire theater so that siege conditions are approximated and movement reduced to a minimum. The classic example is the western front in the recent war. On the other hand, less densely populated districts, such as Russia or Palestine, cannot support such enormous forces; in them therefore, even under tactical conditions favoring immobility, operations will tend toward mobility because the defense will always have flanks which can be turned.

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Furthermore, to overcrowd such a theater is only to handicap oneself; thus much of what appears sluggishness in the British operations during the American Revolution is to be explained by the fact that George III's government was using armies so large as to strain the resources and communications of eighteenth century America. Applying this reasoning to the present case, if we assume that American troops in the future are likely to operate in densely populated regions, such as the northeast and north center of the United States, or in narrowly limited regions, such as the Canal Zone, then we should prepare for conditions approximating those which brought about trench warfare on the western front—for instance, great masses of artillery and heavy artillery and still greater masses of ammunition. If however it is at least equally probable that we may have to operate in sparsely inhabited regions, such as the Philippines or the southwestern states, then mobility will be at a premium and weight of artillery fire, especially of heavy artillery, will be at a discount, and so will the chance of successful antitank entrenchment.

WITH these preliminary data and estimates of the future in mind we may approach what is perhaps the most important military question of the day: is or is not mechanized attack likely to bog down before a modern defensive? Obviously, while no final answer can be given without actual war-time tests of the new matériel, the best answer now available is to be had jointly from the historian of tank operations and those familiar with what the new inventions can do.

Military history can further contribute to the discussion by reminding us of the sweeping tactical changes again and again brought about in the past by changes in matériel seemingly of little importance compared with today's tanks. While it would be going too far to insist that all tactical changes had been the direct result of changes in matériel, still something of an arguable case could be made even for such a far extreme proposition as that.

Such changes begin with the very beginnings of continuous written record: Herodotus, the father of European history, tells us how more than two thousand years ago, the first contact of the Near East with its future conquerors, the Greeks, in their solid metal armor was taken by a certain Egyptian king as the answer to a dream of his that "men of brass" would appear, so intensely did the Orientals, half naked or at most furnished with linen corselets, fear the invincible new monsters. While it would be wrong to claim metal armor as the sole cause of the Greek victories over Orientals from Marathon to Alexander, it would be still more mistaken to neglect it as an important contributing cause.

Turning to modern times, the instances are almost embarrassingly numerous. Thus the skirmishing warfare of the American and French Revolutionary campaigns, to say nothing of Napoleon's, seems to have been made possible by the iron ramrod originally introduced by Frederick the Great; with the older wooden ramrod a man had to stand up in order to reload, so that nothing but standing cover was much use to him. Equally important is the influence of Gribeauval's improvements in the French artillery upon the wars of the French Revolution and Empire. Without neglecting his reörganization of the artillery personnel, it remains true that his improved gun carriages and standardization of parts contributed much to that superiority in artillery which just prevented the raw French levies of Valmy and Wattignies from being swept away by the trained veterans of the Kings of Europe. So with the infantry rifle; no one would deny that it has been the chief cause of wiping out the old close-order battle formations of infantry and their replacement—even in the massed attacks of 1914-18—by at most a series of skirmish lines. As early as 1777, in the decisive campaign leading up to Burgoyne's surrender, Morgan's handful of less than 400 rank and file of riflemen played an important part. Before their arrival the British and their Indian allies had had it all their own way in scouting and skirmishing; Morgan more than turned the tables. In the Crimean and Italian campaigns of the 1850's, and still more in our own Civil War, the general armament of infantry with even muzzle-loading rifles was enough to condemn decisively the old close-order formations; in the Franco-Prussian and Russo-Turkish wars the breech-loading rifle swept them away altogether. As to the breech-loading, rifled field gun, its effect from its first appearance in the hands of the Prussians of 1871 was so striking that a historian like Belloc gives the French declaration of war against an opponent so equipped as an instance of historical events so extraordinary as not to command belief were they not established by detailed and abundant record.

A very perfect instance of the advantage to be gained by just anticipation of the tactical effect of new matériel is the German use of machine guns in the early stages of the World War. Although as early as 1898 John Henry Parker's Gatling gun battery before Santiago had clearly indicated several of the many tactical uses possible to machine guns, and although certain British machine gun officers in India had worked out a fairly advanced machine gun doctrine, nevertheless in 1914 no general staff but the German had an idea of what machine guns could do. Every other command, while admitting the great power of the new weapon in exceptional tactical cases, believed it was good for little in general warfare. The price of such an error proved high.

All told, therefore, if a snap judgment based neither upon detailed research or specialized knowledge be permitted, it would seem that the very least the responsible authorities should do in regard to mechanization is to hedge. With the example of machine guns in 1914 before them, if it appears that there is even a fair outside chance of successful mechanized attack against the modern defensive then that chance promises results well worth trying for. Clearly the results of success would be so sweeping as to justify spending a high proportion of the funds available to the peace-time establishment in order to achieve them. To take the metaphor of a horse race, even if mechanization be not considered our one best bet for the future —as it may prove to be—even then we should certainly place some of our bets on so promising a young horse. On him we might "make a killing"; without him it would seem that the best we can hope for is a stand-off.

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ASSUMING the tactical value of mechanized attack to be admitted so that a considerable mechanized force is in contemplation, military history can tell us something of the form such a force is likely to take. Strangely enough

the examples here come not from the recent but from the distant past; a group of writers of whom perhaps the best known is Liddell Hart have seized upon the analogy between the tank and the armored cavalryman who was the backbone of armies from the late fourth to the late fifteenth or early sixteenth century. Some writers including Belloc and John Buchan—mistakenly in the opinion of the present writer—have even gone so far as to extend the "cavalry era" during which mounted men were the chief arm so as to include the entire sixteenth and a good part of the seventeenth century. At all events cavalry was certainly the chief arm say from 382 A. D. at least until somewhere around 1500.

Incidentally the beginning of the cavalry era is still another example of a change in tactics and organization to which new matériel contributed: at some time between 350 and 580, probably nearer the earlier than the later date, cavalry first began to be equipped with stirrups.

At this point I turn aside for a moment inasmuch as the mention of the cavalry era with its free use of armor suggests a possible development of armor in connection with the light tank. We know from Liddell Hart's recent "Remaking of Modern Armies" that at least one model of light British tanks was without headcover for the occupant. Such an arrangement has at least the advantage of much freer vision than any turret however generously slotted, and might provide a more supportable temperature for the operator during long marches and in hot climates. It would seem that the resulting deficiency in protection might be in part made good by some type of helmet fitted with face and neck defenses like those illustrated and discussed in "Helmets and Body Armor in Modern Warfare" by Maj. Bashford Dean, formerly in charge of the armor unit of the Ordnance Department in 1917-18.

To return to the cavalry era, the first point it suggests to us is that of specialization. We have all laughed at the medieval knight for his many servants and attendants; for his refusal to take the field without at least a squire to dress and undress him in his armor and a groom to lead his spare horse.

But it now appears that an army built around its tank corps must be organized like the late Roman and medieval armies built around the armored horseman and must differ from the nonspecialized armies of the recent past much as the armies of the cavalry era differed from the nonspecialized armies of the earlier Roman period. In both cases a force which relies chiefly on a highly specialized type of fighting man must necessarily support him by a fair number of attendants who can also do the considerable number of necessary jobs from which his very specialization inhibits him. Thus the knights were never a majority even of the cavalry of a medieval army; it was thought extraordinary when they numbered as much as a third of the mounted men. At most they furnished the first ranks in a charge. The infantry could help in the fire fight before the charge, could act as moppers-up behind an advance, and in defensive action could fill in behind the front rank of dismounted knights who—to use the metaphor of naval armor plate—formed a sort of Harveyized steel face for the greater thickness of baser metal behind them. Obviously a highly mechanized army built would have the same need of moppers-up and an even greater need of defensive troops. It would also need men for fatigues, guard duty, etc., for which men Liddell Hart suggests the name "Land Marines."

It would therefore seem suggestive and interesting to study the relation between specialized and nonspecialized troops of the cavalry era. Thus a medieval force with a high proportion of cavalry and especially of knights would be apt to try offensive tactics whereas one which possessed solid infantry would be more apt to take the tactical defensive. Certainly the proportion of armed servants and other nonspecialized troops auxiliary to the heavy cavalry of the late Roman and Byzantine Empire would repay study for these were not haphazard feudal levies but regularly organized professional forces.

Unfortunately this and other possible lessons from the cavalry era are difficult to learn for want of a good military literature of the period. In preparing the brief study included in "Warfare" (Spaulding, Nickerson, and Wright; Harcourt Brace, 1925) the present writer found himself handicapped by the scarcity of good modern work on the subject. The only general view of the period seemed to be Oman's "Art of War in the Middle Ages" which, although by no means without merit, is nevertheless gravely defective. In the first place it is the work of an unmilitary mind; for instance he commits such howlers as to say that the vast crusading armies that marched from Western Europe to Palestine, crossing the half desert plateau of Asia Minor in the face of stubborn opposition, possessed—". . . . little or no organization . . . ." One would like to see him try to take a war strength militia company or even a respectable troop of boy scouts out for a few days peacetime hike without organization and plenty of it. His work also suffers from undue nationalism and from its adherence to theories of history disproved by the research of the last forty years. Following Oman we see Liddell Hart falling into error through his reliance upon the former for the campaign of Adrianople and in general for the beginning of the cavalry era. Delpech's valuable "Tactique Au Treizieme Siecle" is rare and difficult to find nor does it greatly concern itself with the armored East Roman horse archer who as professional soldier is more worth study than the medieval knight. Worse still there are no translations of the important late Roman and Byzantine technical books. There is a good French summary of the "Strategicon" of Maurice but the present writer has failed to find any translation of Vegetius' "De Re Militari" or of the "Tactica" of Leo the Wise. Before intelligent use can be made even of analogies drawn from the cavalry era these deficiencies must be made good.

Translations and reprints of the medieval chroniclers are more abundant but far less important to present day military thought.

FINALLY we come to the most far reaching of the many questions raised by mechanization: will the new matériel put an end to the vast conscript armies typical of war since the French Revolution? Whereas the Revolutionary-Napoleonic period together with the success of the Prussian conscripts over the French regular army of Napoleon III made the "nation in arms" supreme, will the tank help to give superiority to long service professional forces capable of high tactical training?

It should be noticed that other agencies independent of mechanization are working toward this end. As early as

1920 that able writer the late R. M. Johnston in his "First Reflections on the Campaign of 1918" predicted so strong a disgust for conscript service, and for industrial mobilization on the scale made necessary by conscript armies long maintained, as to conclude that "Not for at least a generation to come is it at all probable that the unmilitary west Europeans will permit their governments to get them into the trenches again." Obviously after the end of the Thirty Years War in 1648 it was exactly the same sort of disgust at the prolonged savagery of the wars of religion which brought into being the small standing armies of the 18th century.

Furthermore, in the book just quoted, Major Johnston suggested professional armies as a remedy for the moral and political difficulty. "A force of 100,000 highly trained professional troops could have marched through many places in the western front, and in either direction. By highly trained professional soldiers I have in mind men enlisting as boys at sixteen, passing into the ranks three years later, thoroughly competent in another five years, and serving eight more years thereafter." And this in a book which, I believe, does not even mention the words mechanization or tank!

In any event it seems clear that no nation which, like France, continues to make a huge conscript army its chief reliance can effectively mechanize its ground forces. Two other observations come instantly to mind: first that in the mechanical aptitude of its people and in its automobile industry the United States has a unique opportunity for mechanization; second that the airplane quite as much as the tank may be making in favor of professional armies.

The prospect of a return to professional forces opens up still other historical perspectives which can barely be indicated in this paper. Roughly speaking the government possessed of a huge horde of conscripts, all more or less ill trained as conscripts must be when compared with professional troops, will be reckless of life. Fanaticizing its army and people as best it can with propaganda, it will remain indifferent to losses sufficient to cause the assassination of the most feared and bloodthirsty tyrants of former days. Hence the Napoleonic doctrine of war; i. e., that the primary objective is the armed forces of the enemy. Liddell Hart is nowhere on surer ground than in attacking this theory and in showing that the real objective is to break the will of the opposing government and people—by means of battle if necessary, without battle if possible. Such has been the doctrine of war of virtually all professional armies; that the best general is he who succeeds without sacrificing the valuable lives of his highly trained soldiers. It was the doctrine of the late Roman armies, notably of Vegetius. It was the doctrine of Alva in the 16th century who scorned to take the field until the Dutch insurgents were ten to one against him and was then accustomed to wipe out their field armies, as at Jemmingen, with a loss of seven soldados to seven thousand rebels! It was the inspiration of Marlborough's forcing of the lines of Brabant in 1706, and it was the admiration of Maurice de Saxe. Even in Napoleon's day we find it inspiring the capitulation of Ulm in 1805 and Wellington's maneuvering the French out of the Douro valley in 1813. It may be the doctrine of the future.

Aerial Photography in Military Maneuvers

A DEMONSTRATION of the latest developments in aërial photography was given during the recent joint ground-air maneuvers held in the vicinity of Columbus, Ohio, and Dayton, Ohio. Aërial photography is one of the important elements of observation aviation, and it is intended to have it play an important role in military operations.

Since Lieut. Roy C. Kirtland, now Lieutenant-Colonel, Air Corps, assigned to duty with the War Department General Staff, made the first photograph from an airplane at College Park, Maryland, in the summer of 1911, the Army has made remarkable strides in developing and perfecting this very important phase of military aviation. In taking this first military aërial photograph 18 years ago, Lieutenant Kirtland used his personal kodak of the type in common use at that time. The success of his humble effort brought recognition of the practicability of taking photographs during airplane flights and paved the way for further experiments and research.

Among the present day military aërial cameras which has wide practical application is the multilens camera, including the United States Army T-3, which has five lenses operating simultaneously. With this camera it is possible to photograph in a single exposure from an altitude of 11,000 feet an area of 45 square miles. The area which may be photographed in a given time is limited only by the speed of the airplane.

From the data obtainable from these photographs, Army engineers are enabled to prepare detailed maps of the terrain involved in any offensive within a very short period of time. By actual test a reconnaissance map, covering an area of approximately 170 square miles, has been prepared, printed and delivered in quantities within 36 hours.

While speed is an important attribute of aërial photography, of more military importance is the acquisition of accurate information relative to territory held by an enemy. When information regarding any particular objective in enemy territory is desired quickly, use is made of the quick-work photographic equipment, a recent Air Corps development. By the use of this equipment, the negatives can be developed in the air, ready for delivery within seven minutes from the time of exposure. Thus it is possible for the photographer to obtain his photograph, develop it while in flight, and drop it at his headquarters within the time required to make the flight to and from his objective.

When photographs are desired of a sector well protected by antiaircraft artillery and enemy aircraft, high altitude photographic equipment is utilized. Operating at an altitude between 35,000 and 40,000 feet, the photographic plane is not only out of the range of antiaircraft guns, but actually out of sight to ground observers. The plane is in danger of being molested only by an accidental meeting with a high altitude enemy pursuit patrol. From an altitude of 35,000 feet, a single exposure photographs an area of over thirty square miles.

Small Telescopes for Military Use

The Functions and Properties of Telescopic Apparatus

By Henry F. Kurtz*

PRACTICALLY all military optical instruments are telescopic in nature. It is the purpose of this article to lay the fundamental theory of the telescope before the reader in as simple a manner as the writer is able, showing the function and significance of the elements considered in the design of the telescope, and to acquaint the reader with the properties of good telescopic apparatus as used in connection with small arms military practice. It may be stated with emphasis, before proceeding with the discussion, that the design of a good piece of optical apparatus consists in the exercise of good judgment in reaching a compromise between conflicting conditions. This compromise is, of course, not peculiar to optical engineering, but the optical engineer probably has to deal with more factors in serious conflict with each other than most other engineers.

One of the first requirements for a telescope for any military purpose is that the view obtained with it shall be erect. There are three kinds of telescopes, (1) the Galilean which gives an erect image but a very small field of view, that is, the extent of terrain that can be seen without redirecting it is very limited, (2) the astronomical telescope which gives an inverted image but a satisfactorily large field of view and (3) the terrestrial telescope which gives an erect image and a satisfactorily large field. The terrestrial telescope consists of an astronomical telescope with additional lenses or prisms, the function of which is to erect the image. Since the small field of the Gallilean telescope makes it quite useless for practically all military purposes this discussion will be limited to the terrestrial telescope, approaching it, however, by way of a discussion of the astronomical telescope.

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THE diagram, Fig. 1, represents the astronomical telescope. The objective O and the eyepiece E are represented as single lenses for simplicity. They are separated a distance equal to the sum of their focal lengths. In their common focal point is a diaphragm FD. The small arrow at the left represents an object so far distant from O that rays of light proceeding from any point of it to all points of the objective are sensibly parallel. 1, 2 and 3 represent three such rays proceeding from the head of the arrow to the margins and the center of the objective. Traeing them through, it is seen that they intersect in FD, forming an inverted image there, pass on unchanged in direction to the eyepiece E, after which they proceed in a parallel pencil again intersecting the axis at ExP. It is seen that their inclination to the axis after passing the eyepiece is much greater than before reaching the objective. Rays from all other points of the object proceed in similar fashion and complete the formation of the image. An eye placed at ExP will see an inverted image of the object but under the angular subtense Θ', whereas if the telescope were removed the object would appear under the angular subtense Θ. The angle Θ is called the real field of view and Θ' the apparent field of view. ExP is called the exit pupil. It is the image of the objective aperture formed by the eyepiece.

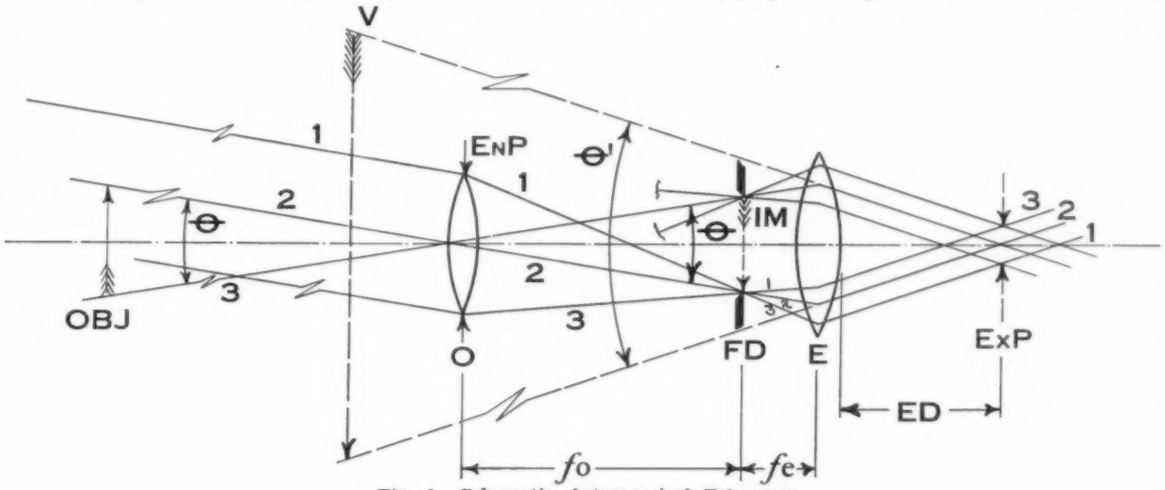


Fig. 1. Schematic Astronomical Telescope.

$$\frac{fo}{fe} = \frac{\tan 1/2\ \Theta'}{\tan 1/2\ \Theta} = \frac{\text{Diam of EnP}}{\text{Diam of ExP}} = \text{Magnification,}$$

OBJ = object, O = objective, FD = field diaphragm, E = eyepiece, ExP = exit pupil = Image of EnP formed by eyepiece, fo = focal length of objective, fe = focal length of eyepiece, Θ = real field = subtense of field diaphragm at objective, Θ' = apparent field, V = image as it appears to eye placed at ExP, ED = eye distance, 1, 2, 3 = rays of pencil of light originating in head of object arrow which is at a great distance from O.

All of the fundamental conditions to be met are contained in the definitions and equation accompanying Fig. 1. An inspection of the diagram shows that all of the light entering the objective and passing the field diaphragm ultimately passes through the exit pupil. It is further true that for a given magnification the size of the exit pupil varies directly with the diameter of the objective. Obviously for greatest light-gathering power, the exit pupil should be as large as the greatest diameter to which the pupil of the

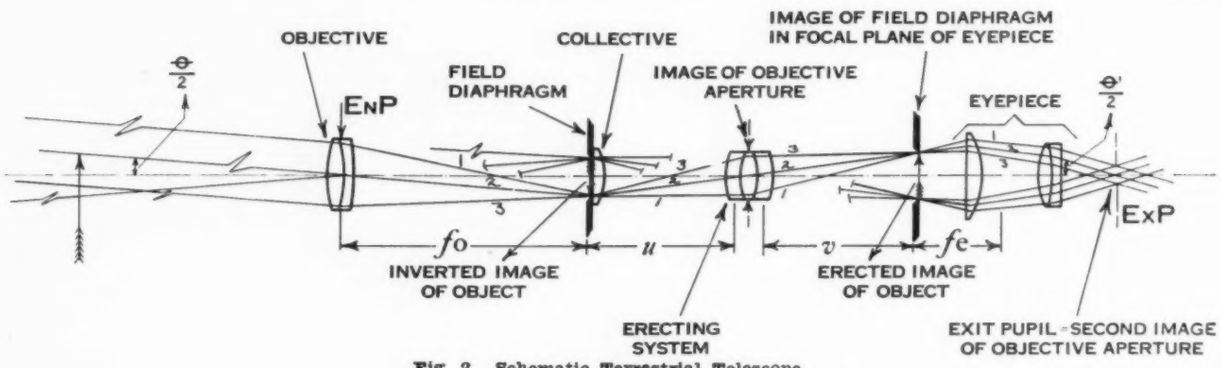


Fig. 2. Schematic Terrestrial Telescope.

$$M = \text{magnification of telescope,}$$

$$M_1 = \text{magnification due to erecting system} = \frac{v}{u},$$

$$\frac{fo}{fe} - M_1 = \frac{\tan \frac{\Theta'}{2}}{\tan \frac{\Theta}{2}} = \frac{EnP}{ExP} = M$$

eye will distend under conditions of low illumination. There is no reason for a larger exit pupil for the light passed by it could never enter the eye. The maximum diameter of the average normal eye pupil and therefore of the largest useful exit pupil is about 7 millimeters according to experiments conducted by Reeves and recorded in the *Journal of the Optical Society of America* for March, 1920. It may be said therefore that an exit pupil as large as possible up to 7 millimeters is desirable. The bulk and weight of a telescope increases very rapidly with increase in size of exit pupil for a given magnification and it may be desirable or necessary to sacrifice the accomplishment of this 7 millimeter limit in exit pupil size to reduction in size and weight of the instrument. Further study of Fig. 1 shows that the eye must be placed *in* the exit pupil if the whole field is to be seen. The exit pupil should not be so close to the eyepiece lens or to the mechanical parts of the telescope that the eye cannot reach it, nor should eyecaps prevent it.

Since the area of the objective aperture limits the quantity of light entering the telescope, and the exit pupil is proportional in diameter to the objective diameter, it follows that the relative brightness of an image viewed through the telescope is proportional to the square of the diameter of the exit pupil. This number is often referred to as relative brightness of the telescope and is often applied to field glasses. It is true, of course, when and only when the pupil of the eye is distended to a diameter equal to or greater than the diameter of the exit pupil.

The objective, as implied above, forms an image in the field diaphragm which is viewed under magnification with the eyepiece serving as a magnifier. The magnifier will serve to enhance the defects in this image. The objective, therefore, must render an image of high quality. It will usually be made of two pieces of glass, one of crown and one of flint. For low powers such as are used in field glasses, the diameter may be made as much as one-quarter of the focal length and the field may be about eight and one-half degrees with maintenance of satisfactory image quality. For higher powers, both these limits will be smaller, and it may be said in general that one may be increased at the expense of the other, that is, if the diameter is decreased, the field may be made somewhat larger and vice versa.

The same limitations apply to the eyepiece. It should be of such quality that it does not destroy the quality of the image formed by the objective. Eyepieces are of many forms, each form having been devised to meet some especially desired condition, such as freedom from color, distortion or other aberration, or to have an especially large field, or long eye distance. The eyepiece used most often on field glasses is known as the Kellner type, working to about 48 to 50 degrees of apparent field and with excellent qualifications in other respects.

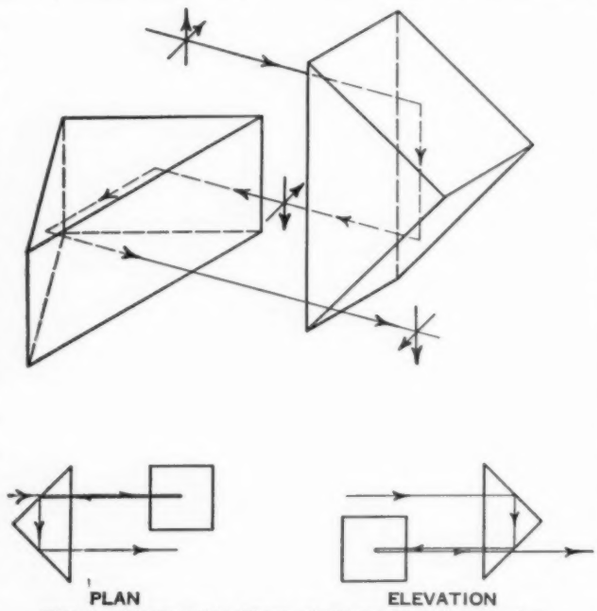


Fig. 3. Perspective View of Prism Erecting System.

Note that the image (indicated by the crossed arrows) is inverted "up and down" only after traversing the first prism and is inverted "right and left" only after traversing the second prism. The two prisms are required completely to invert the image.

There are two ways in which an astronomical telescope can be made to give an erect image. In either case the telescope then becomes a terrestrial telescope. The first method is by means of a lens system placed between the focal plane of the objective and the focal plane of the eyepiece. Such a lens system is called an erecting system. The second method is by means of a prism system usually placed between the objective and the eyepiece. The diagram, Fig. 2, shows a telescope with a lens erecting system. The lenses in this case are drawn as they might actually be made, instead of just schematically as they

were drawn in Fig. 1. The arrow is imaged in the focal plane of the objective, at or near which is placed a collective lens. This image is picked up by the triplet erecting system and imaged in the focal plane of the eyepiece. The eyepiece consisting of three pieces of glass performs exactly as in Fig. 1. The collective lens serves to image the objective in the erecting lens, forcing all of the rays passing the field diaphragm to pass through the erecting lens. It is seen that the erecting lens merely reimages the first image in the field diaphragm in the focal plane of the eyepiece, but erect. The erecting lens must be so designed as to preserve the image quality. Not all erecting systems are triplets. There are many forms, the variation in form depending as in the case of the eyepiece upon the conditions to be fulfilled.

The terrestrial telescope in which erection is accomplished by means of an erecting lens system performs well, but the telescope becomes very long. When it is desirable to keep length at a minimum as in the case of the field glass, the erecting lens system is useless and recourse is taken to the prism erecting system. There are several kinds of prism erecting systems, but the Porro prism system is that most commonly used. It consists of two right angle prisms disposed in the manner shown in Fig. 3. The two hypothenuse faces are toward each other, one prism "lies on its side" while the other "stands on end." By tracing the rays through the prism it is seen that the first prism traversed (the one "standing on end") reverses the image "up and down" while the other prism reverses it "sidewise." This prism system when applied to the astronomical telescope not only converts it to a terrestrial but in addition makes the resultant terrestrial shorter than the astronomical. By separating the prisms the maximum amount allowed by the distance between the objective and the eyepiece a very compact telescope may be made. Advantage is taken of this fact in the construction of the field glass. The only disadvantage of the prism erecting system is the cost, due to the fact that the prisms must be fairly precise and must be well adjusted.

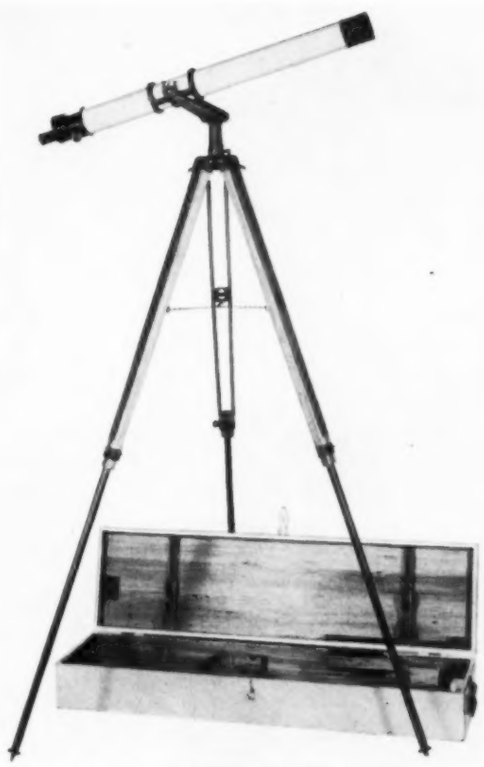


Fig. 4. Observation Telescope.

A telescope such as this is excellent for spotting hits on the range. It may be demounted from the tripod and stored in the case shown. It is provided with interchangeable eyepieces giving powers of 24, 36 and 72.

THE field glass is probably the optical observation instrument most commonly used with small arms. Much of military reconnaissance, reconnoitering and observation of other kinds has to be conducted in twilight, fog, mist, smoke, rain and in other conditions of low illumination and poor visibility. Hence, the first requisite for a field glass is that it have as large an exit pupil as is consistent with the required power and the allowable bulk and weight. The power should not be too high, for experience has shown that an observer cannot see as much with a glass of high power as with one of moderate power owing to the difficulty of holding the glass still enough. As the power increases slight and unavoidable movements of the glass cause such violent motion of the image that detail cannot be seen. A power of six or seven times proves to be best suited to the conditions set up by usage. A glass of this power with the optimum exit pupil of seven millimeters is rather large and bulky, requiring as it does a 49 millimeter (about 2 inch) objective for seven power. Careful investigation by many competent investigators has shown that a power of six is adequate and that the sacrifice of brightness in passing from a seven to a five millimeter exit pupil is small compared to the great reduction in bulk and weight. We must conclude, therefore, that the best compromise between brightness and bulk is given by a glass with a power of six and with a five millimeter exit pupil. This leads us to an objective of 30 millimeters aperture. For a power of six, we need not use a focal length greater than about four times the aperture or about 120 millimeters (five inches). Using a prism erecting system we can therefore make a fairly small and compact glass. Also the field can be carried to about eight and one-half degrees and held of satisfactory definition. This leads to an apparent field of 48 degrees. This apparent field can be satisfactorily handled by a well designed eyepiece, but it is noteworthy that greater field than this can only be accomplished at the expense of definition in the objective imagery and at the expense of distortion in the eyepiece performance.

THERE have recently appeared on the market several glasses characterized as wide-angle glasses. An eight power glass of this type was recently examined by the writer. Measurement showed it to have a real field of 8° 31′ and an apparent field of 70°. Now, application of the fundamental equation given with Fig. 1, connecting power, real field and apparent field shows that for a real field of 8° 31′ and a power of eight the apparent field will be 62°. The question naturally arises, where does the 8° of apparent field discrepancy between measured and calculated values arise? Examination of the so-called "wide-angle glass" showed it to be afflicted with cushion-type eyepiece distortion. Cushion-type distortion is the name given to the cushion-shaped appearance of a square object when viewed through an optical system. It is caused by increasing magnification from the center to the edge of the image. The excess eight degrees of measured apparent field over

the calculated value in the glass examined is that represented by this kind of distortion in the eyepiece. Examination of the marginal image quality of the field glass showed it to be poor. In short, the large apparent field is secured at the expense of marginal image quality due to eyepiece distortion. It is true that the theoretical values of 60° for apparent field and 8.5° for real field are very large for an 8 power glass, and where large field and 8 power are essential it may be wise to accept a lower quality of marginal imagery to achieve it. Before such a glass is accepted,

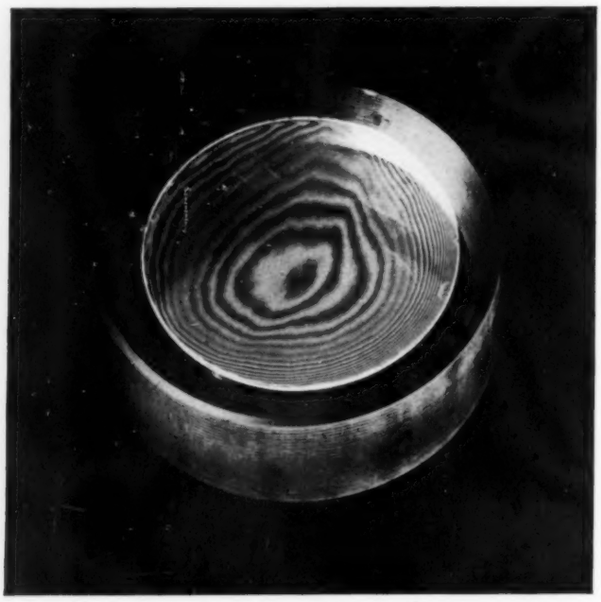


Fig. 5. The surface of a telescope objective under inspection during manufacture.

The lower, larger diameter, thicker disc is the master. The smaller upper disc is the objective under test. The "contour lines" are Newton's interference fringes and each one indicates additional departure of the specimen from the master of a space equal to 1/2 wave length of light, that is at 10 lines from the center spot the space between the specimen and the master is 5 wave lengths or about 0.0002 inch. This specimen is very poor.

however, the purchaser should be sure in his mind that the payment of such a price is justified by his needs.

The projected optical axis of the two bodies of a field glass should be parallel to the axle joining the two bodies to the order of two or three minutes of arc for all positions of the bodies. These errors are magnified by the power of the glass when the optical axes are projected rearwardly from the eyepieces, and divergence of these axes of more than 15 or 20 minutes of arc causes severe strain on the eyes of the observer, especially during protracted observation.

The military field glass is often fitted with a mil scale. The mil is the angle whose subtense is unity at a distance of one thousand. The scale is placed in the plane of the field diaphragm and is seen superimposed on the image. The scale is usually divided in intervals of 5 mils and numbered. Its purpose is to permit the observer to estimate distance when he knows the size of the object viewed, or to estimate size when he knows distance, though it is seldom used for the latter purpose. Suppose the observer notes that a man covers two divisions of the scale, that is, 10 mils. The average height of a man is say 5½ feet. The man's distance must be $1000 \times \frac{5\frac{1}{2} \text{ ft.}}{10} = 550$ ft. That is, one divides the known size of the observed object by the number of mils it subtends and multiplies by 1000 for the distance. The method of estimating size when distance is known is obvious.

It should be understood that the good field glass is the product of good judgment in compromising conflicting conditions. High relative brightness can be secured only at the expense of power, bulk and weight; high power can be secured only at the expense of relative brightness and field as well as in comfort in service; large field can only be secured at the expense of power and image quality. For special purposes it may be wise to pay the penalty to secure the desired factor of performance, but for general purposes the 6 x 30 glass stands supreme.

ONE frequently reads of the virtues of the very small glass for military purposes. It is admittedly light in weight, compact and easy to carry. A comparison of its optical characteristics with those of the standard glass nearest in power will show at what expense these virtues are achieved. An example is a glass of 5 X using objectives of 14-mm. diameter. The exit pupil for the 5 X glass will be $\frac{14}{5} = 2.8$, therefore the relative brightness will be $2.8^2 = 7.8$. The standard 6 X glass with 30-mm. objectives will have an exit pupil of 5-mm. and a relative brightness of 25. It is obvious that the 6 x 30 will work perfectly under conditions of illumination rendering the 5 X 14 absolutely useless. It is also said of these glasses that because there are two fewer glass surfaces to cause reflection losses and because the glass path is shorter causing less absorption the brightness is high when using them. Admittedly there is a saving of about 8 per cent to be credited to the two fewer reflecting surfaces. The loss in transmission through glass is between ½ per cent and 1 per cent per centimeter. The small glass will have at the most 4 cm. less glass than the 6 x 30, so taking absorption at 1 per cent per cm. another 4 per cent may be credited to glass path difference making a total of 12 per cent in favor of the small glass. Taking the original size of the exit pupil as 2.8-mm. an increase in size to 2.96-mm. will give an exit pupil 12 per cent larger in area. Therefore, the saving due to glass path length and reflecting surfaces at the best puts the brightness potentially up to that of a glass with an exit pupil of 2.96-mm. But the 6 x 30 has an exit pupil of 5-mm., and a brightness advantage of $\frac{5^2}{2.96^2} = 2.84$ times over the 5 x 14 glass.

Further, the eyepoint (exit pupil) will be close to the glass in addition to being small. This makes it necessary to place the eye pupil in it very accurately both laterally and axially. It is not necessary to do this so accurately (and hence it is more easily done) with a glass of larger exit pupil and longer eye distance. The small glass is said to be easy to hold. Experiment shows the contrary to be true especially when the user wears gloves. A reasonable "fist full" is most comfortable and convenient.

Mechanically, a field glass should provide facility for focusing at least one eyepiece independently to permit for difference between the eyes of the observer. Opinion is divided as to the desirability of the central focusing button over two individually focusing eyepieces. Decision as to this is a matter to be settled by personal preference. A

good glass should be water- and dust-proof. The glasses used should be hard enough to resist reasonable abrasion and should be chemically stable, that is, noncorrosive. The glasses, of course, should be very transparent. A good field glass should not be heavier than necessary. A glass which has been trimmed down to the point of mechanical weakness to save an ounce of weight will, however, be a constant source of trouble and annoyance to the user. The glass must be sturdy enough to withstand such reasonably rough usage as military operations require. A good glass should be covered with an unobtrusive, durable, protective finish.

A monocular telescope is often used on the rifle range for spotting hits. It should be fairly high in power. The requirements as to exit pupil are not so exacting as those of the field glass, because it will generally be used under conditions making for good, or at least fair visibility. Because of its high power and large size it should be mounted upon a tripod provided with a cradle pivoted to permit rotating the telescope about two axes perpendicular to the line of sight. This permits directing the telescope in any desired direction. It should be provided with several eyepieces, allowing the observer to choose a power appropriate to the work. The telescope should be of the terrestrial or erecting type. The picture, Fig. 4, is from a photograph of an excellent instrument for this purpose. The objective is 60-mm. in diameter, it has a prism erecting system and is equipped with three eyepieces giving powers of 24 X, 36 X and 72 X. The telescope may be dismounted and packed in the case shown.

ANOTHER telescopic instrument is the rifle sight. It consists of an erecting telescope with a cross wire or other index in the plane of the field diaphragm. The telescope is fastened to the rifle by mountings which permit the sight to be adjusted for windage and range. These adjustments are usually made by means of graduated screws. The act of aiming a rifle fitted with open sights consists in successively observing the rear sight, the forward sight and the target, attempting to align them at the same time. This process is followed through automatically and quickly by a skilled marksman, but the process consists of these steps nevertheless. The great advantage in using a telescopic sight does not lie in the fact that it affords magnification but in the fact that the target and the cross line are seen simultaneously and in the same plane. There is no jumping from point to point along the axis of vision as there is in using the open sights. The intersection of the cross wires is the place toward which the bullet is directed and it is easy to bring this intersection on the target. The magnification of a rifle sight should be low for three reasons: (1) a high magnification causes the target to move so rapidly with respect to the cross lines for small movements of the rifle that the rifleman is disconcerted in his attempts to "hold on" the target; (2) the field should be as large as possible to permit the rifleman to find his target as easily as possible, and large field is incompatible with high magnification; and (3) the exit pupil should be as large as possible for ease in finding it and to afford as high a relative brightness as possible for use under adverse illumination conditions. It is also highly essential that the eye distance (distance of the exit pupil from the last lens of the eyepiece) be as great as possible to avoid the possibility of injury to the rifleman due to the recoil. The magnifications usually used are from unity to five or six times, with the preference at about three times. The preferred eye distance is upwards of an inch and a quarter, with about two inches preferred.

Rifle sights are made with both prism and lens erecting systems. The lens erecting system is to be preferred. A moderate length is not objectionable and the straight cylindrical form afforded by the lens erecting type is cheaper than the irregularly shaped prism erecting telescope; it is easier to mount satisfactorily, and can be made very sturdy so that it will withstand concussion and rough handling with less danger of derangement.

Fig. 6. The surface of another telescope objective under test. Only one Newton's ring shows, indicating that the specimen is different from the master by 1/2 wave length or about 0.00001 inch. This quality is satisfactory for low power lenses such as are used in field glasses. For higher power work, this difference must be reduced to a point where no ring shows, but only an even straw color between the specimen and master. In this case the difference will probably be 1/8 to 1/10 of that indicated by one ring, or 0.000004 to 0.000001 inch.

IN making optical parts for telescopic apparatus painstaking care must be exercised in every step. The best of optical glass must be chosen, free from strain and striae and of high light transmission. The glass must be noncorrosive and the exposed lenses must be made of hard glass to withstand abrasion. Small bubbles in the objective lenses and erecting systems are not harmful, but collective lenses must be absolutely free from bubbles. Eyepiece lenses must be free from all but the very smallest bubbles. Glass which meets all of these qualifications is costly because the percentage of a melt that meets them is very low. The radii of curvature, thickness and other constants entering the "formula" must be computed with painstaking care. While the lenses are being polished they are repeatedly tested by interference and are made to match in sphericity and curvature a master glass within a fraction of a wave length of light. Greater errors than this affect the performance of the instrument. The assembly and adjustment of the instrument must be precise in order that the quality of the optical parts may be realized in the form of good performance.

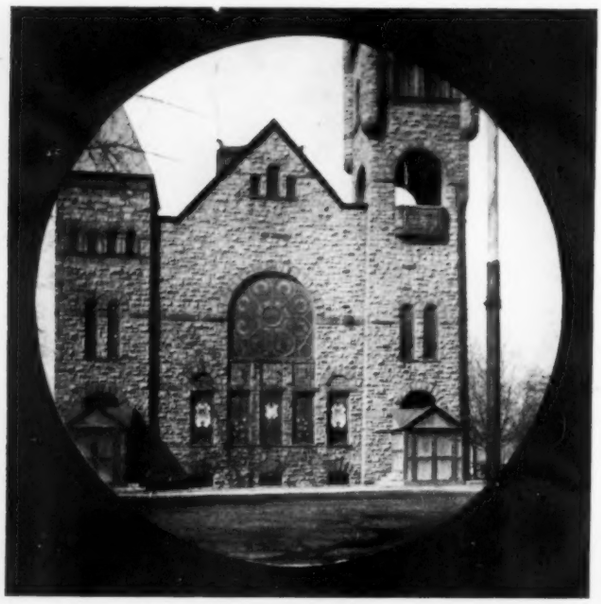


Fig. 7. The kind of image rendered by a good astronomical or terrestrial telescope of moderate power.

Note that the definition is crisp to the extreme edge of the field and that the flag pole and straight lines in the building are perfectly straight.

It may be appropriate here to indicate briefly how to examine a telescope or field glass without laboratory equipment.

1. Hold the glass fifteen or more inches from the eye directing the objective toward the sky. Look at the eyepiece (do not try to look through it). The exit pupil will be seen as a small spot of light. It should be circular and cleanly defined. It should not be crossed by or surrounded by any "shiny" streaks or areas.

2. Place the eye at the eyepiece. The full field should be seen bounded by a sharp circular edge. If the edge is fuzzy, the eye point has not been reached (eye too far from eyepiece or too close to it). It should be possible to reach it comfortably.

3. Direct the telescope at a distant brightly illuminated object which has detail. A brick wall, the bare limbs of a tree against the sky or an advertising bill board with lettering on it will serve well. Focus the telescope carefully giving attention to the center of the field. Contrasty edges of parts of the object seen at the center of the field should not be surrounded by fringes of color. Vertical lines and horizontal lines should be equally sharp for the same focus setting. If vertical lines appear sharpest at a different focus setting from that at which the horizontal lines are sharpest the telescope has astigmatism in some one or more of the optical elements.

4. Now direct your attention to the whole field. It should be evenly and brightly illuminated. If it appears to be covered by a gray haze not in the view, the glass is afflicted with spherical aberration or coma or both.

Fig. 8. The kind of image rendered by a good field glass of moderate power and field.

Note that the definition falls off slightly near the margin and that the flag pole and straight lines of the building near the edge of the field are slightly curved. Some definition is lost in reproduction, and the automatic accommodation of the eye will cause these qualities to be much less obnoxious than they appear to be in this picture.

Fig. 9. The kind of image rendered by a "wide-field" higher power of glass than that used for Fig. 8.

Note that the marginal deficiencies are more marked than in the case of Fig. 8. The same comment regarding effect of reproduction and accommodation in caption of Fig. 8 applies here.

5. In passing from the center to the edge of the field there will be in most telescopes and especially in field glasses a gradual falling off of sharpness. This should not be excessive in amount, not more than just enough to be discernable when seeking it. If this falling off is readily and obnoxiously noticeable the optical system is not well corrected. The difficulty may lie in the objective, eyepiece or erecting system or in all of these parts.

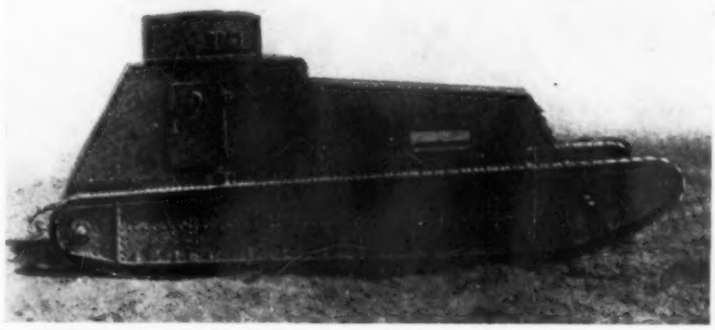
6. Straight lines half way from the center to the edge should appear straight. If they are curved (usually convex toward the center) there is eyepiece distortion present. A good glass (especially binoculars) will show a slight bending of straight lines near the extreme margin of the field but in such small amount as to be not readily discernible. It will be seen only upon search for it. "Wide field" binoculars invariably show this cushion shaped distortion.

Mechanization in Europe

Part I: Russia, Germany and France

By C. C. Benson*

THE layman, especially if he happens to be a carefree cavalryman, should gird up his loins and think twice before he romps gaily into the sacred precincts of the automotive world. Being ignorant, he neither understands nor appreciates why the wheels go round, and it may be dangerous for him even to watch them—he may, poor wretch, become a slave to the particular machine that he should master. If he hopes to escape intact he must have knowledge; for, as Dr. Fritz Heigl says in his Taschenbuch Der Tanks, "Wissen ist Macht." Unfortunately, the author lacks the profound knowledge that enables a man to speak with certainty. To obtain accurate information about fighting machines is difficult. No one can rightly claim a monopoly in this field. Still, we may study what is available, and perhaps learn something from the experience of others. A little knowledge is a dangerous thing only to the man who is content with what he has.



German Light Tank of World War Design. Note springs in rear.

After a decade of sensational aircraft development, military leaders abroad are apparently ready to come down to earth. Competition between private companies insures progress in the air, and army leaders can now devote more attention to equally important matters in other fields. The present urge is towards fighting machines for ground troops, as evidenced by improved tanks, gun carriers, and mechanized forces that have appeared in foreign armies. Tanks are now used in the armies of Brazil, Chili, Japan, Persia, and seventeen European nations. Some of these machines are relics of the World War; others, especially in Europe, are vastly improved new models which have resulted from rapid progress in the automotive industry. The new cross-country fighting machines combine sustained speed with tremendous hitting power, and provide armored protection for the crews. They promise to shift the emphasis in combat tactics from fire to movement; and as they far surpass the World War tanks, they will probably make good their promise. It may be of interest to examine some of the political, economic, and military considerations involved in the mechanization of armed forces in Europe.

WE shall first consider the situation in Europe as a whole. Russia is alone; the continental countries are paired off in mutually distrustful combinations; and Great Britain, with the interests of her great empire at stake, exerts a powerful influence on all the others. The small Baltic states—Latvia, Esthonia, and Lithuania—have precariously maintained national independence; but they are essentially Russian, and if they become convinced of the stability of the Bolshevik regime, it would not be surprising to find them joining the Soviet Union. Germany and Austria have much in common, especially in their attitude towards France, and are drawing closer together. France maintains her cordial relations with Great Britain, and heads a group of smaller nations including Belgium, Poland and the members of the Little Entente—Jugoslavia, Roumania, and Czechoslovakia. The power and prestige of France are indicated by her ability to preserve the Little Entente, which now serves as a check upon Italian ambitions in the Balkans. Italy, friendly with Great Britain but intensely jealous of France, has partially succeeded in aligning Albania, Hungary, Bulgaria, and Greece. Despite the fact that the independence of Albania is guaranteed by the League of Nations, Italy has practically converted that country into an Italian province. She has thus bottled up the Adriatic and secured a firm foothold on the Balkan peninsula. Great Britain, with definite commitments under the Locarno Pacts, is greatly interested in maintaining the status quo and peace in Europe. In Asia and Africa, important British interests conflict with those of the Russian communist leaders; Great Britain's chief concern is to checkmate the international revolutionary program of the Bolsheviks. The League of Nations reflects the alignments indicated above, and can do little more than provide an open forum for the discussion of international problems. Vital questions involve national decision and action rather than international arbitration. Such regional compacts as have been registered with the League are primarily security measures which tend to establish a new "balance of power" in Europe. So long as a spirit of mutual distrust and fear governs European nations, there can be no assurance of continued peace.

RUSSIA dominates the troubled outlook of the powerful European nations. Her unceasing efforts to foster world revolution for proletarian dictatorship, and a standing army of a million men, are a constant menace to the peace of Europe. The Bolsheviks, up to the present, have

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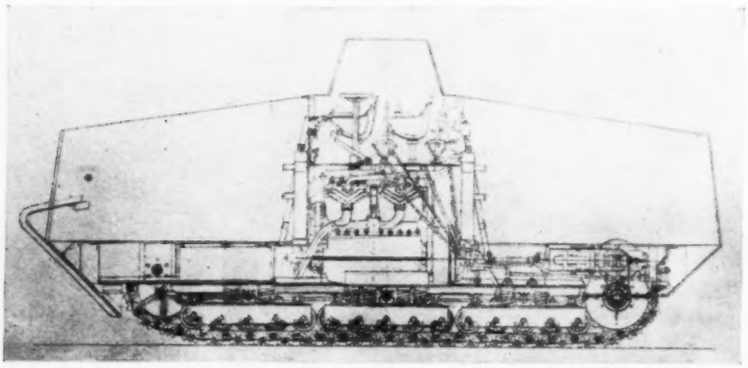
relied mainly upon well financed propaganda to spread their revolutionary doctrines. Joseph Stalin, now virtually a dictator, has consistently followed Lenin's policy that "the soundest strategy in war is to postpone operations until the moral disintegration of the enemy renders the delivery of the mortal blow both possible and easy." Control of the Third International, the central governing body of communists of all nations, enables Stalin, without officially compromising the Russian government, to propagate communism throughout the world. Communist disturbances in China, India, and South Africa show the effect of inflammable material that the Third International for ten years has been spreading among the yellow, brown, and black races of Asia and Africa. Recent disorders in the French army and navy, of proven communist origin, indicate that Stalin still considers propaganda the most effective advance guard for proletarian armies. The international effects of Bolshevik policy and action, whether applied to European nations or to their foreign interests, are of vital importance to the peace of Europe. Communism is frankly imperialistic, with the world as the limit.



German A. 7. V. Daimler, Model 1918. About 40 tons. Note coil springs on track bogies.

While propaganda is doing fruitful work abroad, the Bolsheviks are building up political and economic strength at home. They have a definite program, strong organization, and leaders who maintain discipline. Trotsky and his associates, once powerful in the party councils, are now in exile because they threatened to disrupt the party organization. At present the Communist Party includes less than one per cent of Russia's 140,000,000 people, but schools for children and adults are rapidly educating the masses in the teachings of communism. The peasants, who have had possession of their farms for the past twelve years, will not readily accept the communist theory that all land belongs to the state; the workers employed in subsidized national industries are most easily persuaded. To maintain their power, the Bolsheviks must foster industry and convert the new industrial workers to communism before the agricultural peasants can effectively interfere. Plans calling for capital investments in 1928 of over $600,000,000 for industrial plants and equipment, show the urgency of their economic program. An outstanding feature of new economic order is the Industrial Planning Commission, which aims to eliminate the waste that accompanies haphazard development. It analyzes national economic problems and allocates industrial projects in accordance with national needs. The Bolsheviks have made strenuous efforts to secure enough capital to finance their gigantic industrial projects, and to equip existing plants with up-to-date machinery. Their success may be judged by results; despite seven years of continuous war (1914-1920), Russia is now stronger politically and economically than she was in 1913.

THE Russian military situation remains to be considered. Ever since the diplomatic break with Great Britain three years ago, the Bolsheviks have conducted an intensive propaganda campaign at home to convince the people that the Soviet Union must prepare to defend itself against attacks by capitalistic industrial nations. Flat rejection at Geneva of the 1927 Soviet proposals for complete disarmament gave this campaign fresh impetus. The Soviet representative, M. Litvinov, proposed to dissolve all armies, navies, and air forces; to destroy all weapons, military stores, and means of chemical warfare; to scrap all warships, fortresses, naval air bases, and war industry plants; to abolish all general staffs; to discontinue all citizen military training and all appropriations for military expenses. Appropriations for revolutionary propaganda were not mentioned. On April 16th of this year, M. Litvinov renewed these proposals in an address before the League of Nations Preparatory Disarmament Commission. His eloquence left the delegates unmoved, but no doubt served well for home consumption. Anticipation of foreign aggression has resulted in the formation of a national association, with millions of members throughout Russia, for protection against gas and air attacks. In September, 1928, the effectiveness of air and gas defensive measures was tested in a maneuver at Kiev, a Ukranian city of some 325,000 inhabitants. Business activities were practically suspended during the maneuvers, and the entire civilian population coöperated enthusiastically with the military authorities. In preparation for this exercise, the local newspapers published detailed instructions and dwelt upon the necessity for such thorough organization that in the event of war the city could protect itself unaided. The simple-minded Russian apparently takes his "preparedness" seriously.

If convinced of the hostile intentions of foreign nations, the Russian masses will look upon any war as a struggle for existence. Army units, from the regiment up, are subjected to direct supervision by special political agents who spare no pains to instruct recruits in the Bolshevik ideas of communism. As compulsory service brings a new class of about half a million men into the army each year, these political agents have excellent opportunities to exert great influence. Russia's available military man power numbers about fifteen million men, many of whom have received military training. The armed forces include 250,000 secret police (O. G. P. U.); 600,000 regulars on active duty; 500,000 well trained men in the regular army reserve; and 800,000 in organizations that correspond to our National Guard units. The junior officers are mostly products of the army school system; their leaders are the ablest survivors of recent national and civil wars which gave them plenty of combat experience.

DURING the past eight years, airplanes, gas, and tanks have received special attention. Russian-built planes have been widely used to carry communist propaganda into outlying provinces, and to demonstrate the power of the present regime. With powerful support from the government, and probably the assistance of German engineers, the Russian aircraft industry has made great progress. Chemical industries have been fostered, and their products applied to military training, especially in connection with tanks. Their machines are said to have gas-proof hulls and oxygen containers for purifying air in the fighting compartments, in addition to gas masks for members of the crew; and many of them are fitted with devices for producing gas or smoke. Why these elaborate precautions? The use of lethal gas and toxic smoke in war has not been outlawed even by the United States, and regardless of public opinion on the subject, chemical agents will probably be extensively used in future wars. When we realize that a single machine can carry tons of casualty-producing chemicals, and can operate in spite of gas attacks by airplanes, this development appears worthy of most serious consideration. Whether the Bolsheviks have developed practical methods of degassing contaminated machines is unknown. They first acquired tanks in 1919 and 1920 by capturing about forty French and British machines that had been turned over to Denekin and Wrangel. The captured machines have been rebuilt to improve mechanical performance, increase fire power, and add speed. New tanks have been purchased abroad, and work is now in progress in Russian factories on machines of Russian design. Light and medium tanks predominate, though some work has been done on an eighty-ton tank with two 76-mm. guns, 1.6-inch armor, and a maximum speed of six miles per hour. For the control of these machines, radio sending and receiving sets have been developed. Armored cars, armored railway trains, and self-propelled cross-country supply vehicles have received considerable attention. Training regulations apparently contemplate the use of all these armored vehicles in coöperation with calvary divisions, air formations, and independently in large numbers. The tanks now in service in the Red Army are probably twice as effective as those used by the Allies during the World War.

If the Bolsheviks intend to follow up their revolutionary propaganda, mechanization has arrived at a most opportune time. Their willingness to try new methods is unquestionable; they have used all of Russia for the past twelve years as a testing laboratory for the greatest social experiment the world has ever seen. They must push on or fail, for even in Russia the social order has begun to stabilize without conforming to purely communistic ideas. Increased discontent among the farmers may force the Bolsheviks to seek war abroad as a means of retaining control at home. Their leaders are shrewd enough to realize that new weapons, if properly developed and used, will give the Red armies superior offensive power. Fighting machines will partially relieve them of dependence upon mass armies of uncertain loyalty, and concentrate war power in the hands of trusted party members. Even though vastly in the minority, they could effectively police the country and still carry on offensive operations. Mechanization will help greatly to solve their transportation problems. Railway construction has increased the 1913 mileage by 25 per cent, and the rolling stock now in service is about 30 per cent more than in 1923; but the railways are still entirely inadequate for the rapid movement and supply of great armies. Mechanization of expeditionary troops would reduce the number of men and the tonnage of food, clothing, arms, and ammunition that would be required initially for decisive operations. By eliminating many of the items that were considered essential during the World War, the Bolsheviks could probably maintain powerful mechanized forces in theaters formerly beyond their reach. A surprise attack

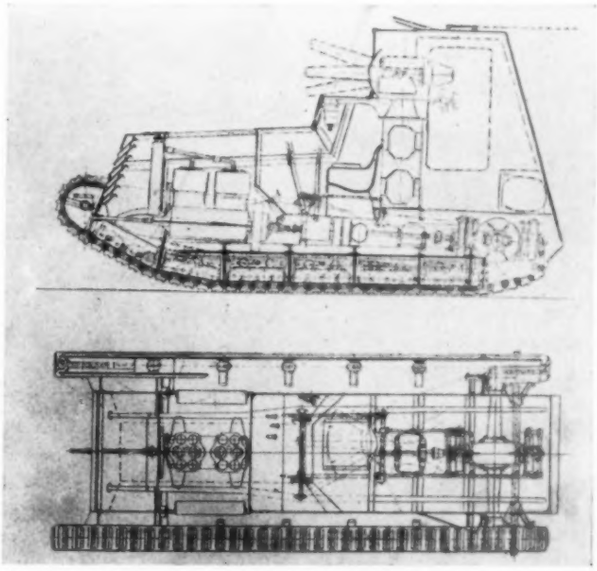


Diagram of German Light Tank Designed During World War. Resembles British Whippet.

towards the west, swiftly delivered, would overwhelm the disunited forces that might be assembled in opposition. The small states—Poland, Czechoslovakia, Jugoslavia, and Roumania—that now form a feeble barrier between Russia and western Europe, are poorly prepared to defend themselves. All are suffering from internal political struggles which have retarded economic development; and all are engaged in more or less serious disputes with their neighbors. The Bolsheviks have never admitted the validity of Roumania's title to Bessarabia, and have unceasingly poured communist propaganda into that sadly misgoverned province. Communist uprisings would probably occur if Red forces moved westward through Bessarabia. If we recall the victorious campaigns conducted 500 years ago by the horsemen of Genghis Khan in their conquest of a large part of Europe, it required little effort to picture fast cross-country fighting machines in a similar role today. Superior mobility on the battlefield is just as effective now as it was 500 years ago.

CAN the Reds produce and maintain a formidable mechanized force? Such forces as are known to exist are took weak for decisive use at present, but they show surprisingly rapid development. Eight years ago Russian industry was a mass of wreckage; now it is able to produce reliable airplanes and fast tanks. A few determined men in control of highly centralized governmental machinery have secured remarkable results along the lines they have chosen to follow; and their facilities for the manufacture of war equipment are constantly improving. Industry is already largely nationalized—a tremendous advantage if

the leaders desire rapid expansion of their mechanization plants. By concentrating on the production of war equipment, these industries, even in their present state of development, could probably supply the needs of the army. Domestic supplies of basic raw materials, oil, and fuel are available. The Industrial Planning Commission has no doubt provided for the necessary manufacturing plants and equipment; and judging by results already obtained, has to some extent remedied the deficiency of technically trained

French NC Renault, Model 1927. Armor: 30-mm. Eight tons. 12 m.p h.

operatives. So far as the army itself is concerned, remodeling would be comparatively easy. The army is young and lacks fixed traditions; consequently there would be little passive resistance to the change. Few vested interests would be disturbed either in the combat forces or in the supply branches. A shortage of suitable officers and men to maintain and operate the machines in the field might restrict their use; but similar difficulties were overcome by the Allies during the World War when the drain on manpower was far more severe than Russia has experienced for some years. The Soviet Union contains many diverse elements and it would be strange indeed if 140 million Russians could not supply the few thousands that would be needed in a mechanized force. Changes wrought by the Revolution, for better or for worse, have given the younger generation a new outlook on life. Whether the men now coming of age accept communism or not, they are far more alert mentally and physically than were the peasants of prewar days. This fact should be recognized in estimating their potential value for service in mechanized units.

Expense is another item that must be considered. From the peaceful taxpayer's viewpoint, investment of large sums in fighting machines appears extravagant. The machines may be obsolete before there is any occasion to use them. However, the Bolsheviks control the purse strings of the Russian government; they have spent large sums, needed for internal development, on propaganda abroad, and certainly will not hesitate to invest heavily in fighting machines if they see fit. In addition to direct taxes, the government has a large income from its complete monopoly of foreign trade and from concessions that have been leased to foreign corporations. It owns the raw materials, manufacturing plants, and all banking institutions. Funds to pay for the manufacture of fighting machines would have to be taken from other projects, but there is no doubt that ample funds could be made immediately available. In figuring expense, the initial outlay is a small part of the total required for active operations in war. An article by Mr. Herbert W. Alden, in the S. A. E. Journal of May, 1919, referring to the use of British tanks at Cambrai in 1917, states, "The saving in ammunition—which would have been used according to the old system in this one engagement—equalled the entire expense of the tank development up to that time." Mr. Alden's valuable work in our Ordnance Department during the war enables him to speak with authority. If other savings, such as man-power and transportation, are added into the account, the balance is strongly in favor of mechanized war equipment. The Bolsheviks could easily justify their expenditures for fighting machines on the grounds of eventual economy.

Under able and determined Bolshevik leadership, Russia can no doubt produce and maintain strong mechanized forces. Reliable information about the Red Army is scant; hence, some of the foregoing discussion is necessarily based on conjecture. Directives have been issued for the formation of independent mechanized units and for a large number of tank regiments; and regulations for their training have been published. To what extent Russian mechanization plans have been executed is uncertain; but one thing is sure—progress in the organization of mechanized units will whet Bolshevik zeal for world revolution.

THE Treaty of Versailles prohibits the use of tanks in the German army. This fact endows mechanization with exceptional interest for the younger generation, and the World War experiences of the veterans serve to stimulate serious study of the subject. Those most interested in the construction of fighting machines have sought employment in countries where treaty restrictions do not apply. German technical experts have assisted in the production and presumably in the operation of Russian machines. The new Czechoslovakian tank, of the combined wheel and track type, was designed by Herr Vollmer, chief engineer for the construction of German tanks in 1918. It is perhaps significant that the Swedish tank, which can find little employment on Swedish terrain, is remarkably similar to the light tanks that Germany was forced to dismantle in 1919. Dummy tanks propelled by man power are being used for training purposes at home; but abroad German engineers are perfecting their designs and gaining experience in methods of construction. There can be little doubt that certain German factories now have blueprints and tools for making modern tanks that have been thoroughly tested. When circumstances change, Germany will be well prepared to apply her highly developed industries, if need be, to the rapid production of war machines.

In the meantime, antitank defense receives great attention. The proposed defensive measures are naturally based on disasterous World War experiences, but show appreciation of the fact that present day tanks are much faster than those used in 1918. Information on foreign fighting machines has been collected and published. Details of the American T1 E1, model 1927, light tank were published in Germany and Austria when all matters pertaining to this machine were considered confidential in our own service. Specific data on weight, dimensions, speed, crew, armament,

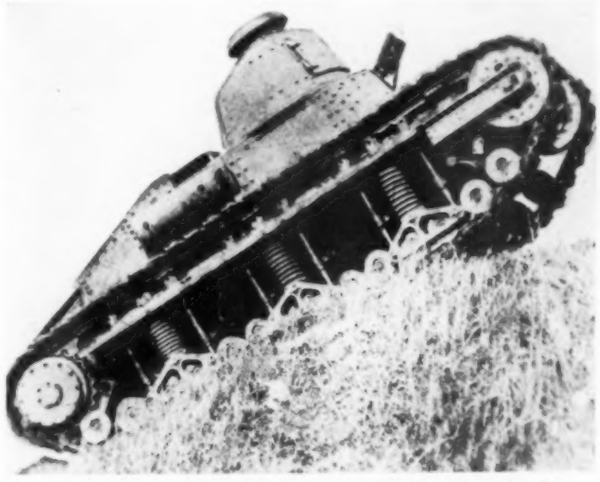
armor, vulnerable points, and other characteristics, with photographs and diagrams drawn accurately to scale, are being circulated among those in the military service. Military writers have made exhaustive studies of fighting machines and their tactical uses, and have published several books on the subject. As a result of this laborious research, and encounters with tanks in 1917-18, the Germans have evolved carefully considered methods of antitank defense. *They have changed their combat organization, equipment, and training to meet, as best they can, the new conditions imposed by tanks.*

THE combined use of tank obstacles and antitank fire is the basis of their present defensive tactics. Artificial obstacles such as trenches, traps, barricades, palisades of posts or rails, and mine fields are considered; but their value is heavily discounted on the ground that there will seldom be enough time or labor available for the necessary construction. Strong emphasis is placed upon the selection of defensive positions which are protected from tank attacks by marshes, water courses, thick woods, precipitous slopes, or large boulders; even though the resulting position sacrifices important features that would be desirable for defense against troops that have no tanks. Antitank weapons, organized in depth in conjunction with defensive machine guns, form the real basis of the defense.

The weapons to be used are as follows: Infantry rifles with armor-piercing ammunition; minenwerfers; flame throwers; caliber .50 machine guns with armor-piercing ammunition; automatic and semiautomatic infantry cannon of 20-mm., 37-mm., and 57-mm., with high velocity ammunition and wide traverse; 77-mm. guns, horse drawn; 77-mm. guns mounted in automobiles. Some of these weapons, particularly the heavy machine guns, are designated as special antitank guns; they are to be camouflaged and remain inactive until hostile tanks appear.

Infantry is trained to fire on enemy troops until hostile machines are within comparatively short range, and then concentrate their fire on the eyeslits of the machines. Artillery training includes much practice in direct fire on moving targets. A horse-drawn battery of six 77-mm. guns, primarily for antitank defense, is assigned to each infantry regiment. In each infantry division, there is a battery of four 77-mm. guns, mounted on automobiles, whose duty it is, in coöperation with infantry cannon and horse-drawn 77s, to destroy with direct fire at short range enemy tanks that penetrate the defensive position. Mobile fire units to supplement the fixed defenses are considered highly essential. Both passive and active antitank measures that can be carried out with available means are to be fully utilized. German military leaders keenly appreciate the combat value of the tank. They have already done everything that they can under present conditions to neutralize its power, and by so doing have prepared all ranks for changes that may come in the future.

AN effort to isolate the most powerful factor in the forces that have governed French policy since the World War leads inevitably to national security. The loss of 1,400,000 men in the war has made security a national obsession. In addition to maintaining her entente cordiale with Great Britain, and giving strong support to the League of Nations, France has signed regional compacts with Belgium, Poland, Czechoslovakia, Roumania, and Jugoslavia. These compacts tend to make France the champion of weak states, and thus commit her to direct participation in all the troubles of Europe. A westward move by the Bolshevik forces, or a thrust into the Balkans by Mussolini, might easily bring French armies into action. With their usual firm grasp of realities, the French see clearly that the development of new weapons—gas, submarines, aircraft, and tanks—has practically eliminated the possibility of localizing future conflicts in Europe. Submarines have opened the sea lanes, and airplanes have flattened the Alps. It would be extremely difficult, in the event of war, for France to unite her associates under one commander; but the strategic use of highly mobile French units would serve effectively to coördinate their actions. France earnestly desires continued peace in Europe, and is doing all she can to insure arbitration of international disputes. However, she maintains a powerful army which has the strongest air force in the world. African troops to augment the strength of French units are being trained in the French colonial possessions. Whether the League of Nations can handle major issues or not, France is prepared to safeguard her national interests.



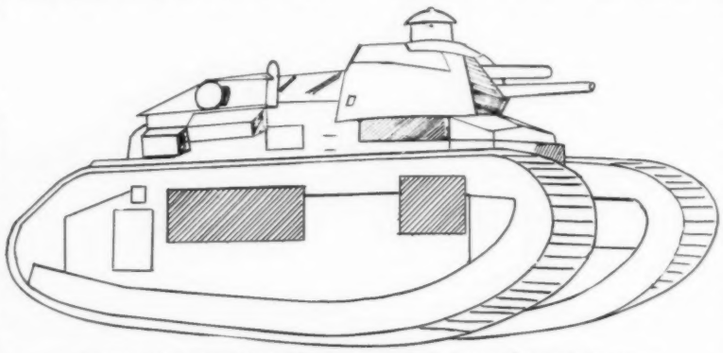
French NC Renault, Model 1927. Well spring tracks. Engine in rear. Driver in front.

PARTIAL mechanization of ground troops has been an accepted policy in the French Army ever since 1917. The successful use of tanks on the Western Front, in Morocco, and in Syria, to secure decisive results without staggering losses, has convinced French army leaders that fighting machines conserve man power. To mechanize a large part of the peace-time army is considered impracticable because of the expense involved; yet to ignore the changes that are being made abroad is obviously unwise. New fighting machines and new antitank weapons are far superior to those used in the World War. If France had to go to war today, she would make immediate use of the 2,300 World War tanks that she maintains in constant readiness for action; and would at once begin mass production of new equipment to provide her armies with strong motorized and mechanized elements. A book recently published in France, "Motorization in the Armies of Tomorrow," by General Allehaut, discusses several phases of this

problem. The author proposes, among other things, to strengthen certain cavalry divisions, which now employ only a few armored cars, by adding motorized and mechanized units. As the proposed organization embodies features of interest, it merits detailed consideration. The missions to be assigned to the new divisions—reconnaissance, security, and combat—are identical with those heretofore given the cavalry. The new division is to be organized in three tactical echelons, as follows:

Reconnaissance Echelon

Calvary brigade (two regiments) supported by: horse-drawn or pack artillery and machine guns; artillery, tractor-drawn or on self-propelled mounts, armored, capable of rapid movement across country; armored cars, either caterpillar track or wheeled machines, capable of maneuvering across country at good speed; a squadron of observation planes.



French 2C Gasoline-Electric Power Plant. Sixty-eight tons. Maximum speed nearly 12 m.p.h.

Combat Echelon—

Cavalry brigade (two regiments) supported by: two or three groups of artillery, part horse-drawn and part motorized on cross-country vehicles; one or two batteries of direct fire accompanying guns on self-propelled mounts; one or two companies of light tanks, armed with heavy machine guns; a group of engineers, motorized for cross-country travel, with demolition equipment, antitank mines, road material, and bridging equipment; combat train, part animal-drawn and part motorized.

Reserve Echelon—

Infantry, half brigade, motorized for cross-country travel, supported by: one artillery battery (six guns) on self-propelled mounts or drawn by tractors, capable of cross-country maneuver; light tank battalion (less units attached to the combat echelon); machine gun battalions with partially armored cross-country vehicles; radio tanks for each battalion and higher headquarters; field trains, part animal- or tractor-drawn and part trucks suitable for road travel only.

In addition to the organization outlined above, General Allehaut advocates the formation of a motorized division for duties similar to those of the present cavalry division; and the increased use of motor vehicles in certain infantry divisions. His views on these matters are in close agreement with those of the French General Staff. Their problem is threefold—to maintain an army in constant readiness for immediate action; to prepare for transition from man power to machine warfare; and to evolve mechanized units for future use. General Allehaut's proposals are admirably calculated to meet French needs during the transition period. Active operations against an enemy equipped with modern fighting machines would probably force the French into prompt adoption of similar equipment; but their present policy is to avoid costly experiments and to progress slowly.

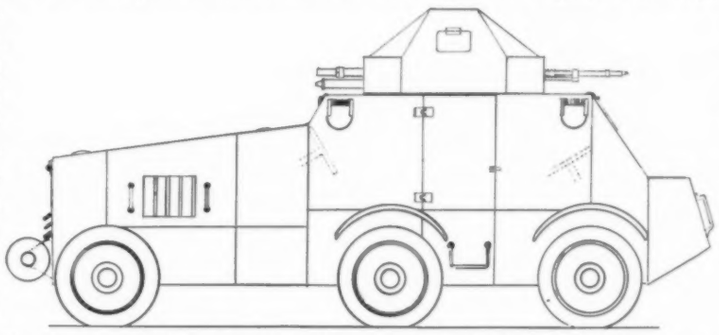
THE probable development of mechanization in France has little apparent relation to the present status of her mechanized units. Post-war conditions have not favored the adoption of new machines. The Treaty of Versailles prohibits the use of tanks in the German army, and as Germany is still the controlling factor in French war plans, there has been no pressing need for France to replace her numerous World War tanks with more modern ones. Furthermore, lack of money for new equipment has delayed admittedly desirable changes, not only in the French army, but also in the armies of her associates, all of which use French tanks. The deficiencies of the 1917 Renault are recognized: it is slow, lacking in fire power, has a limited radius of action, and is vulnerable to the fire of modern antitank weapons. There are, however, a large number of these machines on hand and they will have to be used until better ones are obtained. The French army leaders have experimented with new mechanized equipment and tactical methods for future use; but for the present, they propose to make the best of what they have.

The French tank organization, equipment, and training, are similar in many respects to our own. Constant emphasis upon the necessity for tanks to support infantry has led to the absorption of tank units by the infantry, and the elaboration of coöperative methods in the attack. The present tank establishment includes forty-seven battalions, of which about half are active. Two of these battalions are equipped with Mark V* and 2C heavy tanks, and all the others have 1917-18 Renaults—a total of about 2,300 fighting machines in addition to supply and radio tanks. These machines are used in field exercises about one month in each year; they are then put in readiness for immediate action and placed in storage. Ordinary training is conducted with additional machines—seven per company—that are classed as unfit for combat service. In this training, most of the time is devoted to camping, entraining, detraining, approach marches, and driving at night, to give the tank crews practical experience in preliminary operations that are necessary for effective coöperation with infantry in the field exercises. In view of the limited mobility of the tanks now on hand, French plans for the closest possible coöperation between infantry and tanks are perfectly logical.

TANK development work is carried on by a specially selected group of officers, amid elaborate precautions to preserve secrecy. Knowledge of experimental work is withheld even from members of the regular tank battalions. Such information as is available indicates determined efforts to modernize the old Renaults, and extensive experiments to develop new tanks which vary in weight from three to a hundred and thirty tons. Some of the old Renaults are to have their machine guns replaced with short-barreled

75-mm. guns, and are to be equipped with improved Kegresse rubber tracks. The expense of renovation is small compared to the cost of a new tank.

Efforts to improve tank tracks have followed two main lines of experiment—steel and rubber. The old metal tracks are noisy and heavy, require constant lubrication and adjustment, and so reduce the speed of the tank that it has no strategic mobility. The new tracks, made with numerous short plates of high grade steel, are lighter, more durable, and less noisy than the old. The substitution of ninety-six short track plates for the former thirty-two heavy ones on Renault tanks used in the Polish army, increased the speed of the machine 50 per cent. Further increase in road speed resulted from the use of rubber pads on the track plates; but with tracks thus equipped the machine was difficult to turn. The endless rubber track developed by Kegresse made the tank so difficult to turn that forward wheels had to be provided to facilitate steering. As originally made, this track depended on friction for its driving power; it gave poor traction on snow or ice, and was subject to rapid wear. Many of the former defects have been eliminated and the improved track is now considered suitable for use on Renault tanks. It now consists of an endless fabric and rubber belt, with detachable driving lugs inside and rubber cushioned pressed steel plates outside. Worn lugs, cushions, or plates can be replaced individually. In soft soil, both the cushions and the plates are in contact with the ground; on highways, only the noiseless rubber cushions. Increased durability, positive traction, and better ability to surmount obstacles, are some of the advantages claimed for the new track. It has survived a 950-mile test run on a Renault tank without undue wear, and has given the machine a speed of nine and a half miles per hour—double the former maximum. Further improvements in either the steel or rubber track will make the light tank less dependent upon truck transportation.



French Armored Car. Recent design on commercial six-wheel-drive chassis.

Experiments with the 3-ton St. Chamond wheel-and-track tank have been rather disappointing. This tank has a crew of two men, and carries either a machine gun or a light cannon in a revolving turret. The change from wheels to tracks can be made in one minute without dismounting; to reverse this process, one member of the crew must dismount to block the tracks, and the time required is about ten minutes. As this machine needs no truck to carry it around, it has interesting possibilities; but its comparative lack of maneuverability and inability to surmount obstacles are serious faults.

A NEW heavy tank weighing 68 tons, called the 2C, is worthy of note because no other nation, with the possible exception of Russia, has developed a heavy tank since the World War. So far as is known, only ten of these machines have been built. The 2C carries a crew of one officer and ten men; has one 155-mm. gun or two 75s, four machine guns mounted, with four more in reserve; and is equipped with radio. Driving power is furnished by two 350 H. P. gasoline motors, through an electric transmission which permits great flexibility of control and facilitates steering. The armor is variable up to 45-mm. in thickness; but despite its weight, this machine has a maximum speed of slightly more than eleven miles an hour. Because of its weight and height, the 2C requires special railway transportation facilities. Plans have been made for the construction of a 130-ton tank, and there are some French officers who advocate tanks weighing as much as 600 tons. Such monsters would, of course, have to be shipped in sections and assembled near the intended place of employment. The French make specific provision for the protection of their tanks by means of artillery fire, smoke, and airplanes; but to protect a dreadnaught from destructive fire would be difficult. Cost, difficulties of transport, and probable lack of maneuverability, are valid objections to the construction of these supertanks. As the necessary money could probably be spent more profitably on other projects, the French are not likely to be carried away by visions of an impregnable land battleship.

THE 1927 Renault NC light tank is easily the most interesting feature of French tank development. It carries a crew of two men and can accommodate a short 75-mm. gun. Armor on the fighting compartment is 30-mm. thick, as compared to 16-mm. on the 1917 Renault. Even with this thick armor, the tank fully equipped weighs less than eight tons, and can be readily transported on a heavy duty commercial truck. The hull is similar to that of the old Renault, with the driver in front, the gunner amidships, and the engine in rear—an excellent arrangement. A 60-horsepower motor enables the machine to attain a maximum speed of 12 miles an hour. The running gear is a great improvement over that of the old model. The steel track plates are lighter and stronger than before; unsprung weight is minimized by three large coil springs on each side of the body, which absorb most of the jolts; and the rear driving sprocket is raised well out of contact with the ground, so as to avoid battering the engine and gears. The caterpillar tracks have been extended to the rear and the tail eliminated. By providing elastic track suspension and distributing the weight properly, the designers have given the machine good balance. Anyone who has driven a Renault will appreciate the advantages of a well-sprung flexible track. Instead of standing the machine practically on end to surmount a rigid obstacle, the new running gear enables the NC to proceed on a comparatively even keel; instead of halting to fire, as in the semirigid Renault, a tank gunner in the NC can fire accurately while in motion. The offensive power of the tank, and its chances of survival, are thus greatly increased. It would be desirable for the NC to have another man in the crew, greater speed for use

on favorable ground in emergencies, and a stronger motor to furnish reserve power for hard pulls. Unfortunately, it must depend upon a tank-carrier truck for its strategic mobility. Nevertheless the NC tank is an extremely formidable and sturdy weapon, and it has enough battlefield mobility to worry the best of the enemy gunners.

EXCEPT where special machines are obviously necessary, as with tanks, full use of current commercial vehicles is the rule. Coöperation between the military authorities and manufacturers has resulted in the development of new machines that are suitable for either commercial or military use. Substantial subsidies help Renault, Citroen, Berliet, and other firms to pay the cost of development work on machines that have military value. The government furnished generous backing for the Sahara expeditions that tested the Citroen half-track machine and the Renault six-wheeler. The military authorities encourage and assist private companies that have undertaken to establish regular motor transportation service for freight and passengers in the French colonial possessions in Africa. It is undoubtedly advantageous for the government to foster extensive commercial use of these machines in times of peace, so as to place the manufacturers on the best possible footing for rapid production in an emergency. The effects of this slow but sure policy are apparent in many phases of army mechanization activities. The artillery, for example, has no self-propelled gun mounts other than those provided by installing 75s and short 155s in tanks. The caterpillar tractor, which finds comparatively little employment commercially, is used to haul only the heaviest guns; and wheeled tractors or trucks are favored for transporting heavy, medium, and light guns. A pilot model of a combination wheel and track vehicle for the heavier guns has been made; but lack of funds and the fact that it is not a commercial product have prevented its general adoption. There is a strong tendency towards the motorization of corps and divisional artillery, which is now horse-drawn, but there is little evidence of actual mechanization. For the present, the expense is considered too great. In other words, the artillery has gone as far as the present state of the French automotive industry will safely permit—and no farther.

IN developing armored cars the French have tried a number of different machines that have interesting possibilities. The 3-ton St. Chamond wheel and track machine, mentioned in the preceding discussion of tank development, has been considered for possible use as a tank and armored car combined. The 1924 model of this machine showed considerable improvement over the model of 1921, but as yet the designers have been unable to make it into an agile cross-country machine. The St. Chamond is a non-commercial product, but practically all other models are built on commercial truck chassis made by Citroen, White, Renault, or Berliet. The Citroen car is a half-track machine which has been used extensively in Syria with satisfactory results. The White, Renault, and Berliet are wheeled vehicles which have been modified so as to provide controls for a driver in rear. The six-wheeler, with driving power on all six wheels, has performed exceptionally well; it pulls through deep sand or mud with ease. There are usually four men in the armored car crew—front driver, rear driver, and two gunners. The armament includes a machine gun for use against personnel; another machine gun, or at least a suitable mount, for high-angle fire; and a 37-mm. high velocity semiautomatic gun. The 37-mm. gun will enable these cars to attack hostile armored cars or even light tanks, with some chances of success. Armor carried is said to be proof against caliber .50 armor-piereing ammunition at all ranges over 50 yards. As the latest models weigh less than nine tons, the armor is probably not more than three-eighths of an inch in thickness; its ability to protect the car depends largely upon sloping the plates so as to decrease the chances that enemy gunners will secure direct hits with normal impact. Simultaneous operation of front and rear wheels for steering, similar to that used on the 1915 model of the America F. W. D. truck, is not unusual. Efforts to produce puneture-proof resilient tires have met with considerable success. Provision for ventilation, numerous well arranged observation slits, and periscopes for use in action, are other interesting features that have been built into French armored cars of recent design. Supplies of fuel, food, and water, sufficient for several days, give the new cars a great radius of action. Armored cars are provisionally organized in squadrons, which correspond to our armored car troops. They are used primarily for reconnaissance, in close coöperation with the cavalry.

MECHANIZATION in the French army reflects the period of transition through which the army is now passing. Compulsory service laws have recently been changed so as to reduce the period of active service with the colors. As a result, the standing army—the covering force—will have less numerical strength in the future than heretofore. World War equipment, especially automotive equipment, has deteriorated; and much of it will shortly have to be replaced. In anticipation of changes that will be necessary to maintain the covering force at the desired combat efficiency, army leaders have made extensive studies and tests of new mechanized equipment. They have in the NC Renault light tank a machine that is far superior to the 1917 Renault. Their experiments with armored cars improvised on commercial truck chassis have produced machines that are readily obtainable in large numbers and well suited to the intended role. Similar vehicles with considerable cross-country ability have been developed for the transportation of infantry machine guns, and supplies. Tractors of both the wheel and caterpillar types, and trucks suitable for artillery and other services, have been selected from the commercial field. In short, the French military authorities know definitely what mechanized equipment they want; and when money becomes available, they will be ready to spend it wisely, on equipment of proven value. Plans for the organization, training, and tactical employment of mechanized units have kept pace with the development of matériel. We may expect that the French will proceed, as rapidly as funds permit, with their plans for the mechanization of ground troops. Their armies, supported by powerful formations in the air and well equipped mechanized units on the ground, will then meet fully the requirements of national security.

(*To be continued*)

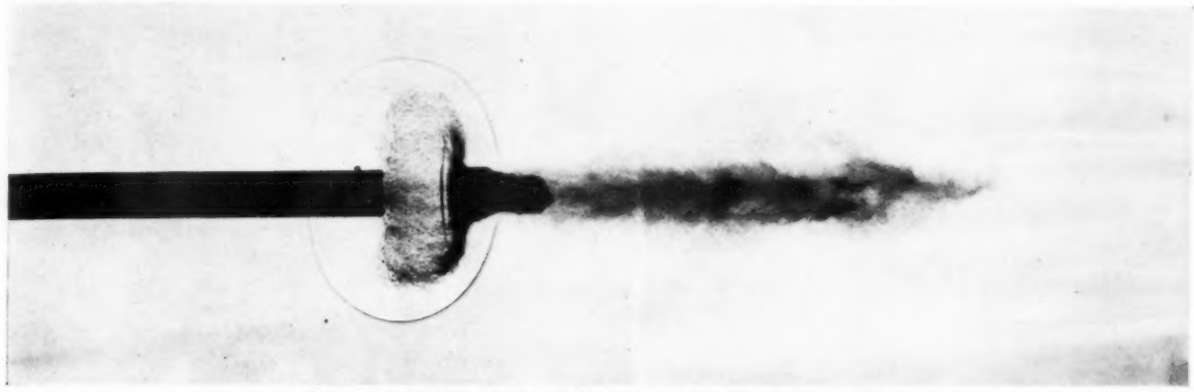


Fig. 1. A charge of shot about 1½ inches out of the muzzle.
The gas being deflected from the base of the felt wads which are at the back of the charge, indicates that the blast from the muzzle is still tending to accelerate the charge. Evidence seems to indicate that this force on the base of the charge in the region near the muzzle contributes materially to the scattering of shot.

Gas Checks and Concentrators

An Investigation of Their Behavior and Results

By C. T. Ervin*

THE problem of reducing gas leakage and increasing pattern concentration provides a field of investigation which has already received the attention of various experimenters for more than a century. Special gas checks and concentrators have been recommended and many rather weird claims made relative to the results they produce. The investigation of the action of such devices is greatly facilitated by the use of spark photography. In fact, it is the only means whereby the behavior of such devices can be observed, and the results made available to the shooter.

Let us first consider a general phenomenon present during the discharge of any shot shell. The shot charge has a continuous but varying force acting on its base tending to force it out of the gun after the powder is ignited. This force continues to push on the rear of the charge, while the pressure in the gun is being relieved, until it has moved a distance of from three to six inches outside of the barrel. By observing the gas from the muzzle in Fig. 1, it is evident that the pressure is still tending to accelerate the shot charge outside the barrel by forcing the felt wads against its base. While the charge is in the barrel, there is a rigid restraint by the gun barrel to lateral motion, and acceleration takes place only along the trajectory. However, after the charge leaves the barrel, it has no longer the restraint to prevent motion of the individual pellets in a direction perpendicular to the trajectory. It should also be borne in mind that the shot are moving at approximately the velocity of sound as they come out of the muzzle and the air resistance is considerably greater along the trajectory than it is at right angles to the trajectory.

By referring to Fig. 1 it will be seen that just after the shot charge leaves the muzzle, it is a cylinder roughly approximating the dimensions of the charge in the loaded shell. It is therefore evident that the individual shot being in close contact and with a force pressing the felt wads against the base of the charge, will crowd together, and there being no rigid restraint to motion perpendicular to the trajectory, will receive an impulse outward from the trajectory. Having received such an impulse the individual pellets will continue to scatter as they move toward the

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Fig. 2. A charge identical with that shown in Fig. 1 after the charge has moved out 16 inches from the muzzle.
The spreading of the rear of the charge has become more pronounced.

target. This effect is shown in Fig. 2 by the shot charge having a flattened base after it has moved a little farther from the muzzle. This spark photograph was taken of a

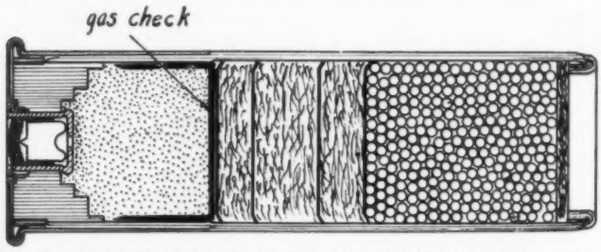

Fig. 3. Drawing to show the manner in which the brass gas check was loaded to maintain a higher barrel pressure.

charge identical with that shown in Fig. 1 after it had moved out 16 inches from the muzzle, and the effect of the spreading impulse due to the felt wads pressing on the rear of the shot charge has become more pronounced. This force only lasts for a distance of from three to six inches, but it imparts an outward velocity to the shot which makes them travel farther from the average trajectory the longer the range.

Bearing in mind the above phenomenon of the wads pressing on the base of the shot charge after it comes out of the barrel and has no rigid restraint to motion at right angles to the trajectory, it is readily understood why a pattern will decrease as the velocity of the load increases, since to obtain this increased velocity, the pressure in the barrel at the time of exit of the shot charge is greater if the powder used is the same and the increase in velocity is due to an increased weight of the powder. The presence of the above mentioned phenomena will also explain the fact that shells loaded with a thin brass gas check behind the shot charge and felt wads, see Fig. 3, gave patterns 10 per cent lower than shells loaded in the same manner without the gas check. This is shown in Fig. 4, which is a spark photograph of a load identical with that of Figs. 1 and 2 except the thin brass gas check is at the rear of the felt wads. It will be noted by comparison with Fig. 2, that the spreading of the rear of the charge is more pronounced when the brass gas check has been used. This is apparently due to the gas check maintaining a higher pressure in the barrel and therefore a greater force acts on the base of the charge after it leaves the muzzle.

ANOTHER factor which may contribute to bad patterns has been revealed by means of spark photography. This factor is the pressure that may be set up in the space between the shot pellets if poor wadding is used. There is no wadding or gas check, however perfect, that will eliminate entirely leakage of the powder gases into the shot charge. This leakage gas can be seen ahead of the shot charge just after it leaves the muzzle (Fig. 1). In cases where higher pressures are used the gas can be seen escaping in all directions from the shot charge even after it has moved out a distance of 12 inches from the muzzle. It is evident that if gas under a pressure greater than that of the atmosphere is present in the space between the shot pellets as they leave the muzzle, they will receive an outward impulse dependent on the magnitude of the pressure. With high grade felt wadding it is possible to reduce this pressure and hence its detrimental effect on the pattern to a minimum.

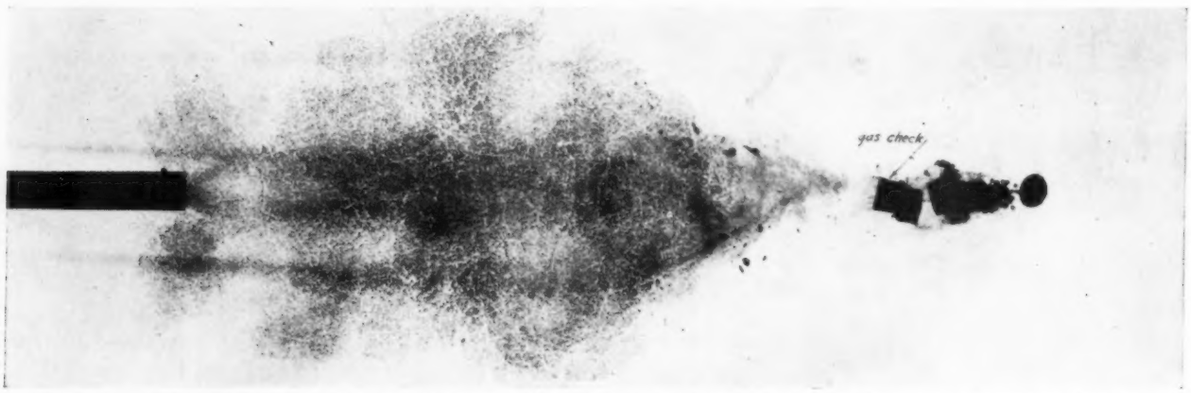

Fig. 4. Spark photograph of the load identical with Figs. 1 and 2 except for the brass gas check (see Fig. 3). Note that the spreading of the rear of this charge is more pronounced than the back of the load shown in Fig. 2.

In view of the above considerations, it at first appears that a concentrator cup loaded in the shell as shown in Fig. 5 should entirely prevent the spreading of the base of the shot charge and should also prevent a pressure in the interstices of the shot charge from disturbing the pattern. Such a cup having an air resistance much greater than that of the pellets should soon fall behind and an excellent pattern should result. This brings to our attention the many forms of shot concentrators which are all, in general, unimportant modifications of the one shown in Fig. 5. Such a concentrator, according to those who advocate it, is supposed to carry the shot toward the target for some unknown distance and then leave the shot undisturbed and free to start scattering after the cup has been left behind. This method has been recommended for long range shotgun loads for many years, and even at the present time literature on hand-loading of shot shells contains various

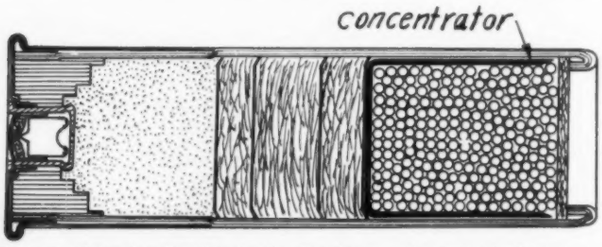

Fig. 5. Drawing to illustrate the form of concentrator cup used in experiments referred to in this article.

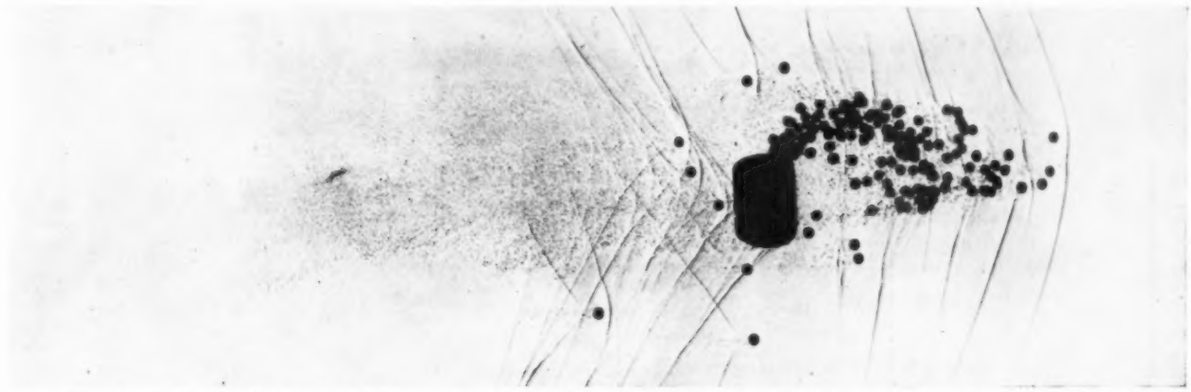

Fig. 6. A Spark photograph of the concentrator shown in Fig. 5 at a distance of 12 feet from the muzzle.
After being fired with a charge of 1¼ oz. No. 6 shot, the velocity being the equivalent of 3¾ drams of regular bulk smokeless powder. Note that the concentrator is turning in a contra-clockwise direction and the shot are being thrown from it by the centrifugal force. It is seen that in addition to the usual disturbances of the shot on passing through the air the pattern will depend on the speed of rotation and on the position of the open end of the cup during the time the shot are being thrown out.

recommendations for concentrator cups without regard to the fact that experiments with such loads show them to be very erratic.

An investigation of the action of concentrators of the type shown in Fig. 5 was carried out in order to determine the causes of the erratic patterns. The result of tests of patterns at 40 yards shows that shells loaded in the same manner and tested under the same conditions using the concentrator had individual patterns that ranged from 41 to 83 per cent. The average of all tests was 67.5 per cent. Another point of importance is that the center of the pattern in individual cases was thrown as much as 3 feet from the point of aim. This means that the maximum distance between individual pattern centers for shells loaded with the concentrator, might easily be 6 feet at 40 yards. The center of the pattern on regular shells tested for comparison with the concentrator load did not vary more than 6 inches from the point of aim.

Shells loaded in the same manner without the concentrator gave pattern variations on the average which were much less than the values for the concentrator, however, individual patterns occasionally vary to approximately these limits. The average pattern of the loads without the concentrator was found to be 67 per cent or for all practical purposes the same as with the concentrator.

SPARK photographs were taken of the concentrator at various distances from the muzzle to determine in what manner the shot became separated from it. Fig. 6 is a spark photograph of the concentrator described above at a distance of 12 feet from the muzzle. It will be noted that the concentrator is spinning in a contra-clockwise direction and the centrifugal force on the pellets is throwing them from the cup. While the concentrator has eliminated the spreading of the base of the shot charge due to the disturbance near the muzzle and reduced the disruptive effect of pressure in the shot interstices, it has at the same time introduced another factor which will impart a velocity perpendicular to the trajectory to some of the pellets. The velocity perpendicular to the trajectory that is imparted to the shot is dependent on two factors. These factors are the speed of rotation and position of the open end of the cup during the interval of time required to allow the shot to spill out. Thus, let us consider the following purely hypothetical case in which we shall assume that the cup rotates at uniform speed. If all the pellets left the concentrator while the open end was pointed either directly toward or directly away from the target then they would be given a maximum velocity at right angles to the trajectory. This would mean a badly displaced pattern, but not necessarily a low pellet count in the standard 30-inch circle. Also if all of the pellets left the concentrator when the open end was pointed at right angles to the trajectory they would not have a velocity at right angles to the trajectory, and, other factors being equal, a good pattern properly placed should result. However, all the shot do not leave the concentrator at once, and a part of them might leave at either of the above mentioned stages or at some intermediate phase leaving the remainder to be discharged as the cup continues to rotate. In addition to the above, the problem is still further complicated by the fact that the concentrator cup does not rotate at constant speed but in all probability suffers the most erratic angular accelerations and decelerations so that we could readily obtain any of the following combinations: (1) A good pattern properly placed; (2) a good pattern badly displaced; (3) a very bad pattern, whose center may lie anywhere within a 3-foot radius from the point of aim; (4) a pattern which would be a modification of any one or all of the above patterns depending on the position of the cup when the major part of the shot was discharged.

ANOTHER common concentrator of this type is made by taking a regular shot shell and cutting a line around the shell about the center of the wadding. This cut is made practically through the paper shell and when the shell is fired the section ahead of the cut will go out of the barrel. A felt wad is left in the section and it travels as a unit and starts to rotate until the centrifugal force of the shot pellets force the wad out of the section. The shot then discharge in the manner described above.

Experiments with concentrators of the form shown in Fig. 5 show that an average pattern using such a concentrator is no better than the average pattern of a like load without it. Such experiments also show that the concentrator pattern will frequently miss the point of aim by three feet in 40 yards.

The Progress of Antiaircraft Development as

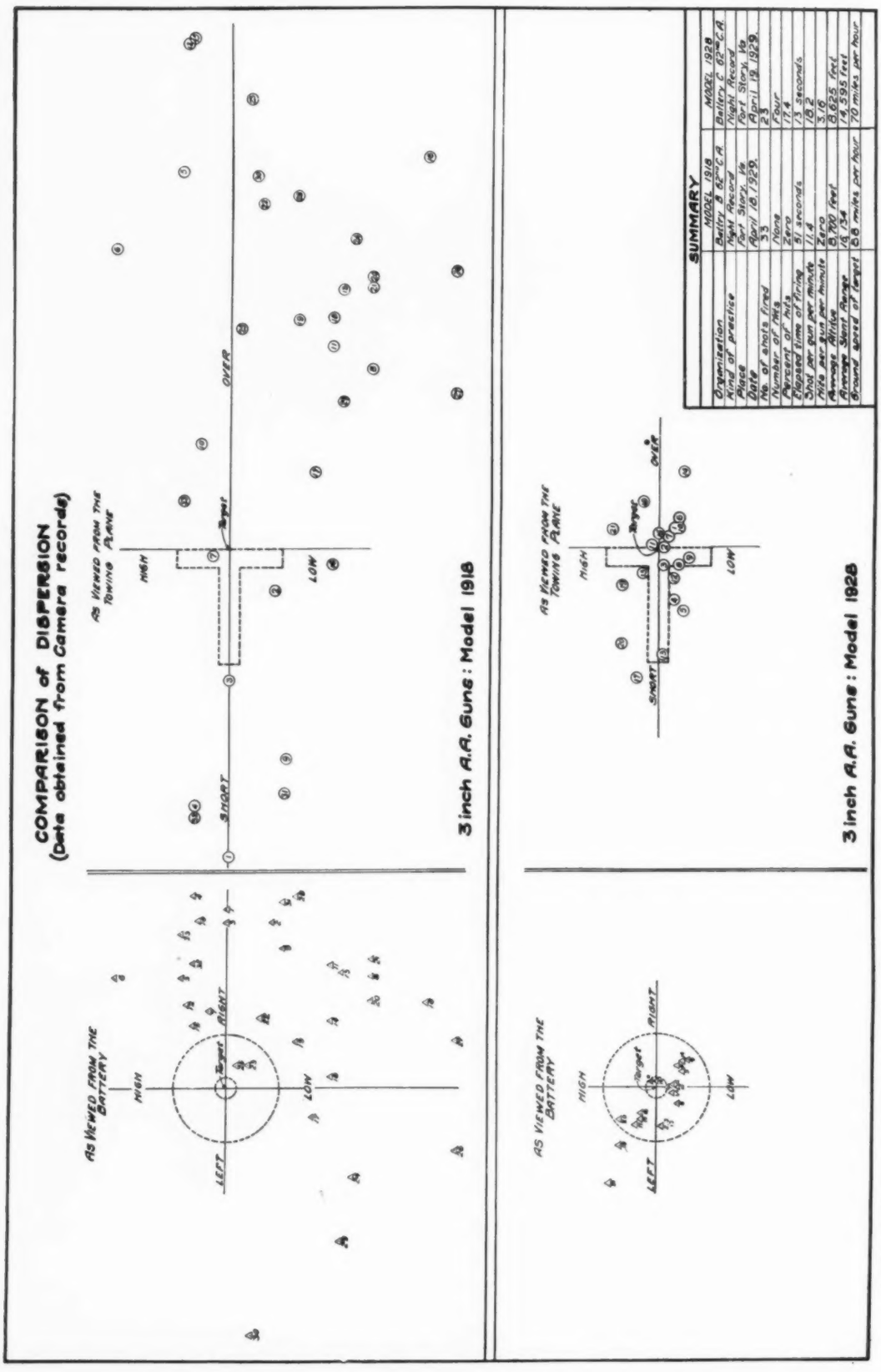

Chart Showing the Improved Results Obtained from New Ordnance Antiaircraft Equipment in Comparison with Matériel of the World War Period.

The comparison firings as plotted above were made by the 62nd Coast Artillery Regiment, Battery B using the old equipment, Battery C the new, firing on successive nights at the Fort Story tests, April, 1929. It will be noted from the summary of data above that with the Model 1918 gun 11.4 shots were fired per gun per minute with no hits, while with the new equipment 18.2 shots were fired and 3.16 hits were registered per gun per minute. The conditions under which the two tests were made were virtually identical.

Recorded at Recent Firing at Fort Story, Va.

General Summerall, Chief of Staff, U. S. Army, Observing the Antiaircraft Firings at Fort Story.

The marked improvement of the new equipment over the old as demonstrated by these firings is shown graphically on the opposite page.

"WE HAVE just ceased firing from four of our latest model antiaircraft guns. During the past few years there has been marked improvement both in the guns and the instruments used for determining firing data with the airplane targets. It is necessary, of course, that we should develop an antiaircraft gun along with the development of the airplane. These two great developments should go hand in hand. We cannot have airplanes everywhere to protect troops, peoples, and various military establishments. The speed with which planes may approach troops and magazines is such that we could not hope to have planes in the air. We plan to have antiaircraft guns always ready with skilled troops to meet airplanes should the enemy be able to bring his formations to our organizations. There has been great progress in the skill of our troops, in the development of guns and in the designing of range-finding equipment."—From an address by General Charles P. Summerall, Chief of Staff, U. S. Army, at Fort Story, Va., April 19, 1929.

Educational Orders for Munitions

The Facts of the Case as Presented to Congress

Part III: Statement of H. H. Pease*

WE continue in this issue publication of statements of leading American manufacturers before the Committee on Military Affairs, U. S. House of Representatives, 70th Congress, 2nd Session, on a Bill (H. R. 450) to provide for Educational Orders to Manufacturers by the War Department. The hearings before the Committee began January 11, 1929.

Educational orders are such a vital part of our Industrial Preparedness plans and the statements in their favor are so convincing that, in the opinion of the Editors, the matters presented at the hearings warrant the fullest consideration. To this end the principal statements before the Committee are published serially in these pages.

THE EDITORS.

CONNECTICUT, as you know, was the location of a large portion of the war-time production of small arms, small-arms ammunition, and a large percentage of machine tools.

Shortly after the enactment of the national defense act in 1920 the Manufacturers' Association, of Connecticut, indicated its willingness to coöperate in the industrial preparedness program by an official sanction of its board of directors. A committee on industrial preparedness was thereupon appointed and the members of this committee were tendered appointments on the advisory board of the Bridgeport Ordnance District, which district comprises Connecticut and western Massachusetts.

The closest coöperation has always existed between the manufacturers' association and the Bridgeport Ordnance District; so much so that at the last annual meeting of the district in June, 1928, munitions and equipment to be supplied in the district had been allotted and accepted by manufacturers to the extent of 100 per cent, and a large number of them had made their studies and completed their factory plans.

These manufacturing concerns feel generally that, while they have studied the jobs and prepared factory production plans, they would never have full confidence in their ability to perform until they had had actual experience in manufacturing the equipment or munitions allotted to them to a limited extent or to the extent that could be provided for by educational orders.

As an illustration, one of the most successful manufacturers of time fuzes for shrapnel in the World War, a concern that made over 24,000,000 fuzes without a single rejection or without a single accident, fortunately received an order in 1905 from the Frankford Arsenal which it took them four years to produce because of their lack of experience. They attribute their success in the World War to this experience so fortunately derived through a previous order. Speed is of the essence in the industrial preparedness program of the War Department, and, unless a sufficient mechanical and practical experience can be placed behind the orders now allocated to and accepted by the manufacturers of the various ordnance districts, this very vital phase of the industrial preparedness plans will be nullified.

We can illustrate this further by the experience of the New Britain Machine Company in 1917 when an order was taken for 3-inch anti-aircraft gun carriages. The first delivery was to have been made in six months. It was actually made in 18 months. This delay was due in part to changes in design made after the order was placed and during the time of getting into production. It was also due in large measure to the fact that this company had had no previous experience in the manufacture of the mount and to the fact that all the jigs, tools, fixtures, and gages had to be produced after the order was placed.

Under the present law, on account of the difference in the method of computing overhead expenses, Government arsenals would always underbid the private manufacturers; therefore, the necessity for this amendment, which will lift from the Secretary of War the injunction now placed upon him.

Mr. Chairman, the opportunity that you are giving manufacturers to appear before your committee in reference to the importance of educational orders in time of peace for munitions and equipment from the standpoint of insuring the country's safety in time of war is very much appreciated.

THE preparedness program as conceived by the War Department was based on the experience gained in the World War. The part of this program with which we are concerned, as manufacturers, will be the supplying of the Army and Navy with munitions and equipment as fast as they are needed by the new Army under the preparedness mobilization program. The requirements, as I understand it, have been worked out so that if the manufacturers come through with the production of munitions and equipment allocated to them, the Army and Navy will be supplied with these necessities from month to month as the different units are trained and ready to take the field.

The war material and equipment that will be required, with few exceptions, is not the standard product of any of the manufacturers in this country, and the problem which we, as manufacturers, will have the responsibility of solving is the transposition of our plants from the manufacture of products of peace to the necessities of war.

We are anxious to do our part and, in order to do our part, feel it incumbent upon us to urge Congress to enable the manufacturers of the country, who will have this great responsibility, to prepare themselves by acquiring knowledge in advance, and by studying and planning the manu-

*President, New Britain Machine Company, New Britain, Conn.

facture of the articles they will be called upon to build by actual production in small quantities in peace time through educational orders.

Mr. Trigg, as chairman of the special committee of the United States Chamber of Commerce, has ably discussed the importance of educational orders and has gone into the matter so thoroughly that there is no need of my enlarging upon the points which he has mentioned.

I can, perhaps, give you an illustration of the difficulties that a manufacturer would encounter in attempting to produce munitions and equipment in time of emergency without having had previous experience in the manufacture of the article in question by giving the experience, briefly, of the New Britain Machine Company in manufacturing 3-inch antiaircraft gun carriages in 1917 and 1918.

The New Britain Machine Company was chosen to manufacture this intricate piece of mechanism because of their experience in the manufacture of precision machinery of about the same size and weight as an antiaircraft gun carriage, the supposition being that there were very few concerns in the country better fitted to undertake a contract of this character.

A contract was placed with the New Britain Machine Company on July 18, 1917, for 408 auto-trailer carriages, model 1917, for 3-inch antiaircraft guns. This contract was later increased to a total of 612. One hundred and twenty carriages were finally finished and are now in actual service, I understand, as regular equipment of the United States Army.

The delivery required in this emergency was: 10, January, 1918; 30, February, 1918; 60, March, 1918; 80, April, 1918; 104, May, 1918; 124, June, 1918; 102, July, 1918; and 102, August, 1918.

Almost superhuman efforts were made by the New Britain Machine Company, and every preference was given the planning and manufacture of this work. Facilities were increased, and the deliveries required would have been somewhere nearly approximated if it had been humanly possible. The actual deliveries were as follows: 1, August, 1918; 4, January, 1919; 30, previous to May 1, 1919; 12, May 1919; 36, June, 1919; and 37, July 1 to July 16, 1919.

By July, 1919, the New Britain Machine Company was delivering these gun carriages complete with sighting mechanism, mounted on steel trailers, guns mounted, proof fired, tested and inspected, at the rate of nearly three a day, but they should have been delivered in July, 1918, at this rate instead of in July, 1919.

If Germany had been attacking the United States in July, 1917, it is doubtful whether these guns and gun carriages would have been of any service in July, 1918, and much less in July, 1919.

The New Britain Machine Company was complimented by the United States Army Ordnance on the efficiency in their production methods, and the quality of their products. The delay could have been avoided if the New Britain Machine Company had had educational orders.

IF you have no objection, I would like to go a little further into detail so as to make clear the reasons why it took 18 months to begin delivering these gun carriages in quantity instead of six months, and how a large part of this delay could have been avoided.

The case is that of other manufacturers and particularly the manufacturers who were called upon to make intricate pieces of mechanism, the details of which they were unfamiliar with and of which they had had no experience in manufacture.

I have brought photostatic prints of the assembly and detail drawings of this antiaircraft gun carriage. In order to make this gun carriage a serviceable unit, it was necessary that the parts should be interchangeable for quick repairs or replacements in action. This required that the job should be as thoroughly tooled up as is necessary in the production of automobiles.

Four thousand three hundred and sixty-three different tools, jigs, fixtures, and gages had to be designed and manufactured for this purpose. A large number of these jigs, fixtures, and tool bodies were made from castings. One thousand and six different patterns had to be designed, patterns made, and castings obtained, before the machine shop could begin work on these fixtures and tools required for the manufacture of this antiaircraft gun carriage. I have lists of these tools which are a very interesting exhibit and illustrate, perhaps, as well as anything that could be displayed, the immense amount of preparatory work required before a gun carriage or any other similar piece of equipment can be put into production.

The time required of the engineering organization of any machine shop or manufacturer in the preparation for the manufacture of an article cannot be ignored, and if not provided for will stultify any preparedness program.

In my opinion, an educational order to a manufacturer will be of very little value in the preparedness program unless the Ordnance Department is permitted and instructed to include in that order, although it is only for a limited number of articles, an order for the design and manufacture of all tools, fixtures, and gages that would be required for the manufacture of the article on a production basis.

These items are all special, cannot be designed and made in a minute, and if not in the manufacturer's hands in time of emergency would delay the manufacturer of intricate articles of equipment far beyond the time for which they are scheduled for delivery on the present preparedness program.

These tools and fixtures could be made in connection with the first educational order and stored by the manufacturer or in Government arsenals, but could be used in subsequent preparedness orders and, by their use, the economy in the manufacture of the equipment, compared with manufacture by tool-room methods without fixtures, would pay for the tools in the manufacture of a very few units.

As an illustration: The New Britain Machine Company, under the present preparedness program, is on the schedule for delivery of 6 antiaircraft gun carriages in the seventh month, 10 in the eighth month, 24 in the ninth month, and so on, and the program calls for the same 3-inch antiaircraft gun carriage, model 1917, as is covered by the drawings before you.

THE New Britain Machine Company has made the special tools, jigs, fixtures, and gages to the number of 4,363, and they are now stored in the Rock Island Arsenal. It would be possible, with no change in design, and it would be perfectly practical to expect the New Britain Machine Company to get into production and make the deliveries

called for on the preparedness program because the New Britain Machine Company has had experience in manufacturing this particular gun carriage and because the tools, jigs, and fixtures, above referred to are available. However, the 3-inch antiaircraft gun carriage which the New Britain Machine Company made in 1917 and 1918 is being superseded by a more modern gun carriage.

A pilot gun carriage has been made at the Watertown Arsenal. If this works successfully in tests, it will be adopted and substituted in the preparedness program for the one with which we have had experience in manufacture. The desirability, therefore, of not only the New Britain Machine Company but whatever manufacturer assumes the responsibility for the manufacture of the new antiaircraft gun carriage under the preparedness program, to have an educational order for the manufacture of a few of these gun carriages, is self-evident. The desirability, also, that this order should include an order for a complete set of special tools, jigs, fixtures, and gages, required in the manufacture, from the standpoint of saving time and delay, is evident and, as stated above, the cost of manufacture on subsequent orders for this carriage will be much reduced.

One factor which influenced to a very considerable extent the delivery of equipment in 1917 and 1918, which, I hope, will never be necessary again, to such an extent, at least, was the incompleteness of design. The 3-inch antiaircraft gun carriage, model 1917, had never been built. I hope and believe that the Ordnance Department will never be caught again in an emergency without finished detail designs of the most modern munitions of war, thoroughly tested in service. I hope the department will always have funds available for investigation and experimental work along these lines.

Because the department was not in this condition the New Britain Machine Company received over 400 revisions in the design of component parts of the model 1917 3-inch antiaircraft gun carriage during the process of manufacture. These revisions, in almost every instance, called for changes in tools and fixtures, and the delay in the completion of the work caused by substituting new parts for parts discarded and remachining parts where interferences developed is almost beyond estimate.

In this statement there is no reflection intended as to the ability or sincerity of purpose of the designers of the gun carriage. A situation of this kind would exist in a private plant where production of an intricate machine was attempted from drawings before model machines were built and the "bugs," as we call them, worked out.

In the emergency of 1917 a modern antiaircraft gun carriage had to be designed and production had to be started without so much as a scratch of paper to begin with, and the officers in charge of this job in the Ordnance Department deserve a great deal of credit for their accomplishment.

The pilot mount, or models of other equipment made in the arsenals, would avoid delays from causes as described above. Original deliveries of 18 months would not be necessary, as designs would be established, but for manufacturers to do their part in supplying munitions and equipment under the present preparedness program, it is not only desirable but necessary they have experience that they would derive from educational orders and that they prepare themselves for the emergency by having on hand special tools and fixtures necessary for interchangeability and required for modern methods of production, all of which could be provided for if funds are provided the Ordnance Department for educational orders.

Coast Artillery Target Practice Results

THE Chief of Coast Artillery, Maj. Gen. Andrew Hero, Jr., has completed a study of the results of all target practices in the Coast Artillery held during the year 1928 and has submitted a memorandum to the War Department indicating the results obtained. In general, the target practice year 1928 was highly satisfactory. The excellent results obtained were partly due to the inauguration, in 1926, of a system of scoring all battery organizations whereby all are on a competitive basis.

Prior to the commencement of artillery firings for the year 1928, upon the recommendation of the Chief of Coast Artillery, the War Department prescribed minimum ranges for all seacoast and antiaircraft firing. Notwithstanding the increased range at which target practice was held, the comparison with the similar results for 1927 show marked progress as: The average range of 87 per cent of the practices was greater; increased accuracy was obtained in 58 per cent of the practices; the rate of fire was increased in 98 per cent of the practices; the hits per gun per minute were increased 79 per cent.

Some of the outstanding records for the year follow: In one practice with 155-mm. guns the average time to fire one round was 11 seconds at a range of approximately 15,000 yards and 27 per cent of hits was obtained. In another practice with this type of armament at a range of over 5,500 yards conducted at night 54 per cent of hits was made. In a practice with the 14-inch guns 58 per cent of hits was obtained at a range of approximately 17,000 yards wherein the battery secured over 1.5 hits per battery per minute. A 3-inch gun battery made 68 per cent of hits at a range of over 5,000 yards resulting in 9 hits per gun per minute.

For the antiaircraft artillery marked improvement over the previous year's shooting was obtained. This is especially true with machine guns. In one practice at a range of approximately 900 yards and during 9 separate flights by a tow-target airplane approximately 13 per cent of hits was secured. The rate of fire obtained during this practice indicates that 90 hits per gun per minute were obtained. With the 3-inch antiaircraft guns there was one practice where 45 hits were made at a range of over 15,000 feet.

There were five regiments in which all record target practices were classified as "excellent" (the highest classification for Coast Artillery units). These were: 92nd Coast Artillery (Harbor Defense), Philippine Islands; 2nd Coast Artillery (Harbor Defense), Canal Zone; 15th Coast Artillery (Harbor Defense), Hawaii; 41st Coast Artillery (Railway), Hawaii; 1st Coast Artillery (Harbor Defense), Canal Zone.

How A High-Power Rifle Is Made

The Specialized Technique of Commercial Arms Production

By W. D. Higgins*

THERE is a friendliness that develops between a man and his rifle which seldom is equalled by anything else. It is a strange sort of affection, daily heightened by new expectations, new thrills, new companionship. To this friendliness, one must devote a certain amount of interest and study. As the high-power rifle proves its own qualities, so must its owner develop his own skill—mould the "habits" of the arm to his own shooting habits.

The well-known comradeship of man for his pipe, his dog, his book, does not compare with this—perhaps the fly-casting expert gets a similar unfading thrill out of his rod and reel, though the rifle gives a sturdier, "safe-guarding" relationship. But, the rifle is only worthy of faith, confidence and friendship, as it stands up to the expectations you give it. Your own skill must be met with the finest qualities of smooth, strong action, true rifling, sensitive balance, and the best of materials. It is here that the manufacturer's sides comes into it.

A Special Machine for Drilling Model 99 Savage Receivers—Eight Operations at Once.

NOW, when it came to detailing the operations and processes involved in the manufacture of high-power rifles and in the testing thereof, I felt that perhaps my experience had brought me a bit too close to the subject to avoid sinking into the purely technical. Association daily with the many manufacturing processes involved, might easily lead me to overlook many of those points which would naturally be of interest to the average layman. Therefore, I asked one of my friends—a former infantry sergeant whose experience in the A. E. F., and whose contact with high-power rifles in the woods gave him the proper understanding of what was taking place—to accompany me through the plant of the Savage Arms Corporation, observing the manufacturing of Hi-power rifles, and relating to me the phases which caught his attention.

Naturally we started at the beginning; that is, we began with the introduction of the raw materials into the plant and followed each step through. To enable us to work out a story of sequence we determined to follow the various operations on one type of Savage Hi-power rifles. We selected the Model 99 lever-action rifle because our company was originally organized to manufacture this famous design of hammerless rifle. Although many new models have been introduced, this arm continues to be the outstanding Savage Hi-power rifle in popularity with sportsmen throughout the world.

THE Savage manufacturing operations have been well processed, so that few interruptions occur in the direct routing of material, the primary work being on the lower floors of the plant in the storerooms for the steel bars for barrels, the heavy drop forgings for receivers, the blocks of selected walnut for stocks and forearms, etc.

Each principal component goes to its separate manufacturing building—the receivers to the machine floors, the barrels to the barrel-room and the walnut blanks to the woodworking shop to be manufactured to exact specifications. During the time the major components are going through their individual manufacturing sections or buildings, on other machine floors the many smaller components, such as triggers, sears, bolts, finger levers, special screws, etc., are started so that all parts are brought together again in a finished-part storeroom. They are issued from there in orderly sequence to the assembling floors—to be made into finished rifles.

One of the most interesting phases of arms manufacture is the almost unlimited need for special tools, each operation of any sort requiring its own set of tools. Therefore,

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Barrel Refiling Machines.

arms plants naturally have their own complete toolshops wherein these small grinders, cutters, polishers, and implements of all sorts are made and kept in repair. The manufacture of the tools in the Savage plant requires a large corps of highly specialized workmen, because the turning out of any one of these tools is as delicate an operation as the boring or rifling of a barrel.

ANOTHER highly organized department is that in which all the purchasing and testing of materials is done. The purchasing of proper material and well-timed delivery is one of the most important departments of a manufacturing plant. And this is particularly so in the selection and purchasing of material for Hi-power rifles.

Barrel steel comes to Savage in solid round bars 1-1/16 inches in diameter. This steel is the same high-grade smokeless gun-barrel steel selected after exhausted tests by military experts as the best material available for the manufacture of our caliber .30 Springfield rifle by the United States Government. The physical specification for this steel sets an elastic limit of 75,000 pounds per square inch.

Each lot of forgings, steel and any other material which enters into the manufacture of the rifle is tested by chemists and metallurgists, and is not placed into production until all material has passed a rigid inspection.

FROM the supply-rooms with their rumbling trucks of material moving to different parts of the plant we followed a lot of receiver forgings that were on their way to the machining-floor.

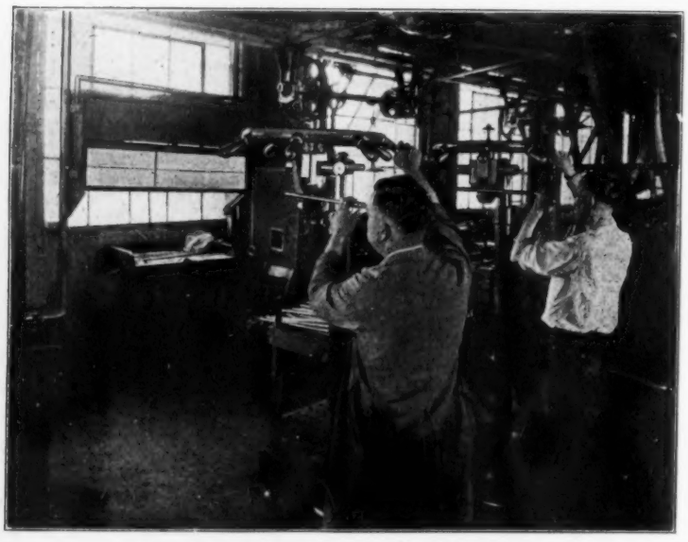
The first and most vital operation in manufacturing begins by grinding the left side and top of the receiver to accurate flat surfaces which act as locating points for all the operations that will reduce the solid forging which weighs seven pounds down to one and three-quarter pounds. It took us an hour to pass through the machining-

A Profiling Machine.

floor, stopping frequently to inspect the operations on the receiver. But the rough forgings we followed from the store-room would not arrive at the finished-parts department until three months later. As a matter of fact, the sergeant made rather a game of trying to keep track of the number of operations involved in the manufacture of a Model 99 Hi-power rifle, and only missed it by about 200.

The enormous preparation of tools and machinery needed to manufacture a rifle was strikingly apparent in these machinery operations. We examined with much interest one machine that was built to perform eight separate drilling operations at one time. Row after row of profile machines were observed, all looking much alike. On close inspection, however, each machine had a different fixture that was built with infinite care in the toolroom to perform one cutting operation.

The receiver in every fixture operation is firmly held by two or four locating holders or guides



Barrel Straightening—A Skilled Operation.

which do not allow any deviation in the cutting operation here performed. The punching of these guide holes and locating points must of necessity be exact. Otherwise every following operation would go wrong. These holes used as locating guides in the early stages of production, eventually are the screw holes for assembling the action. In setting the tools for these fixtures there is less than one-thousandth of an inch leeway permitted, because the slightest deviation would mean a wasted receiver and all the workmanship and effort that had been put on that one receiver would be lost.

On many of these fixtures, two separate operations are accomplished simultaneously. All the operator has to do is to control the levers so that equal pressure is distributed on the receiver throughout the cutting process. This sounds simple enough, and the sergeant who accompanied me could not understand why it was difficult to train men for this work until he took hold of one of the machines and spent two or three minutes in doing what the average workman does in thirty seconds.

A Corner of the Polishing Room.

Assembling the Action of the Savage Rifle.

As we passed through machining-floors, stops were made to examine the intricate gages which are applied to the receiver after every operation to make sure no one operation has gone wrong that would later cause the entire finished receiver to be rejected. Stops were made to watch many of the smaller operations on the receiver and component parts done by girls on ingeniously designed small machines.

IN the stockroom we had seen the long heavy bars of steel sawed to the proper length to make 20-, 22- or 24-inch barrels. At the entrance of the barrel-room we saw these rough bars being straightened and made ready for the boring-machines. The solid bar is placed in a revolving boring-machine on which the drill is stationary and the barrel is spun at a high rate of speed against the drill. These drills are hollow, very hard steel and are kept cool by a constant flow of oil being fed through the drill into the work.

It was noticeable that throughout the barrel-manufacturing rooms the machines were all fed with a very high-grade oil much in appearance like that used in our automobiles. In all the machining-rooms we had previously passed through, most of the machines were lubricated with a white liquid solution made from a high grade soluble oil, mixed with water so that it is the exact texture for each cutting and grinding operation.

In watching the barrel-drilling operation, my companion questioned why the barrels were spun around while the drill was stationary. It was explained that by this process the drill centers itself in the barrel and a straight hole through the exact center is secured. Rows of machines were passed, on which the surplus stock was being taken from the rough barrel. Multiple cutting machines cut

Hand-finishing Stocks.

the surface of the barrel's exterior to octagon shapes, and finished the barrel to its exact exterior dimensions. From here, the semifinished barrels were put on rifling-machines. The workmanship entailed in this type of work must not only be skillful but exceedingly careful.

On rifling-machines, holding five rifle-barrels at a time, the cutters work on a screw doing the cutting operation on the back draw of the cutter. That is, the barrel is held stationary, the cutter is fed through without operating, and as it is drawn back through the barrel it is turned to make the proper twist, shaving a fine steel filament from the barrel. A skilled operator must determine just how fine the cutting has become and must frequently replace the cutters for resharpening. This workman must determine by a proper gage the degree of twist and depth of rifling for the particular caliber of barrel he is working on.

The rifling-machine has an intricate piece of mechanism which automatically presses out the cutting edge of the cutter slightly after it has in turn taken a shaving from each of the grooves in the barrel.

The rifling-grooves vary from four in the .22-caliber rifles to six in Hi-power rifles. The average time for rifling one barrel, or rather for rifling five barrels at a time, is approximately 40 minutes. After rifling, the barrels are then straightened and chambers are cut for the particular caliber cartridge to which these barrels are intended.

Lunch time had now arrived and in discussing our morning's tour of the plant, I asked the sergeant what his first impressions were, and he first said, laughingly, "A profusion of oil." Then he admitted that he was amazed at the endless care and supervision given to the working out of each small part and each operation, and the scientific methods employed to make this manufacturing more sure and more efficient.

TAKING up our tour in the afternoon, we followed the interesting course of the manufacture of stocks and forearms. The aromatic odor of walnut wood, the hum of saws, and the absence of splashing oil made the sergeant remark that here was another industry in itself. Here in orderly process, the blanks or semishaped blocks, were sawed from special kiln-dried walnut. These were put into forming-machines from which rough outlined rifle stocks emerged. The rough stocks were then shaped on special machines to the proper designs for taking barrels, receiver ends, butt-plates, etc.

The rough stock proceeded to the finishing end of the room, where the rifle-receivers that we had seen in process earlier in the day had now reached us clean and polished and had acquired a number.

Workmen hand-fitted the rough stock to a receiver and finished it down to exact proportions by hand. The number of the receiver was stamped on the stock under the butt-plate, and each proceeded on its separate way again—the receiver to be blued and polished, the stock to be varnished and finished.

We followed the finished stock after its final forming to the varnishing room. Here stocks received three applications of varnish, each application being rubbed down with pumice-stone and then oiled. The stock remains three days in the varnishing-room and passes on to the finished-store department with a heavy coating of rubbed-down varnish that makes it weather-resisting under all ordinary hunting conditions.

The sergeant, from his Army training, voiced his opinion that a walnut stock should be finished by an application of linseed oil rubbed in, and asked why the large commercial firearms manufacturers did not finish the stocks of their arms in that manner. It was explained to him that a proper oil finish would require the daily attention of the workmen for at least three weeks and would make the cost very high. Further, in the method of distributing firearms, one of our products might be in the jobber's or dealer's stock a year before it reaches its ultimate customer. During this time the oil finish would have dried out considerably and the arm present a very unattractive appearance. The rubbed-oil finish is much like polishing one's shoes—it must be done frequently to keep its good appearance.

Leaving the wood-working operations at this point the various finishing departments were visited. Naturally, from the machining and cutting of steel, there are bound to be many rough edges and corners that must be smoothed off so that any possibility of untrue operation in the part, will be eliminated. In the filing-room skilled operators were working on the many metal parts that had passed through the machining-room, preparing them for final polishing.

The polishing-room is a hum of high-speed activity. Special carborundum wheels must be built by the skilled foreman of this department for many different polishing operations. Every part is here finished to a glass-like smoothness and then passed to the metal-finishing departments. The small component parts pass through carbon furnaces, where a permanent blued finish is given them. At this point the receivers are heat-treated and hardened at all stressed points to withstand the high pressure of smokeless-powder cartridges to be fired in them.

We followed a lot of receivers that had been hardened and were placed on a truck to go to the barrel- and receiver-finishing rooms. Here the receiver was thoroughly washed to take off all impurities and clean out all dirt. It was then painted with a rust-producing acid specially prepared by the company, and was placed in a steam-room, where it was thoroughly steamed for 24 hours. It emerged from here with all exterior surfaces covered with a bright red rust and was placed on a polishing-wheel, which breaks down the rust-forming texture and smooths out the material. Then it is painted again in the same acid and put back for another steam bath. This operation is repeated for three days, and the receivers and barrels eventually emerge with a heavy black glossy rich coat secured by polishing the rusted surface down and treating it with oil.

ALTHOUGH our day was almost spent, our time had been devoted entirely to the inspection of the manufacture of parts and we had not yet seen a finished rifle. Our arrival at the finished-parts-assembly floor therefore brought us to a dividing line in the manufacturing process. Here every manufactured part of the rifle has been assembled and from here the actual manufacturing of the complete firearm begins.

The carefully worked out production schedule has given the plant management information as to how many of a certain caliber of rifle will be required in the shipping-room at a fixed date. The foreman of the assembling-room

explained to us he had instructions to assemble 100 Model 99 rifles, Style G, caliber .30. He therefore requisitions from the finished-parts stores 100 receivers, 100 barrels, and 100 of each principal component to be distributed to a fixed number of assemblers.

It is at this point that the most skillful operators in the manufacture of a Hi-power rifle are required. While all component parts are made to gage, there is yet enough deviation caused by the wearing away of tools and other minor conditions to make careful filing necessary to accurate fit. It is also necessary to leave some parts slightly oversize for fitting and only the most skilled workmen can fit these parts to the proper adjustment.

All of these men are old hands; most of whom have been with the company fifteen or twenty years. They are capable of discovering any error in machining, drilling, boring, polishing, etc., and in many cases they rectify these mistakes themselves; in other cases they send parts back to their respective departments for correction.

The assembler knows exactly what every small part of the Hi-power rifle is designed for; what its strength must be. He must have a scientific eye; must have been on a number of the different tooling operations himself. For instance, in the fitting of the bolt in the 99 receiver he must be skilled in filing certain bearing points to exact adjustment; he must be skilled in determining the maximum and minimum head space between the face of the bolt and the barrel because after his fitting operation is finished the bolt is then hardened and cannot be further changed. There are 32 major component parts that must be fitted to coördinate smoothly and quietly with each other, and it is most difficult to learn to do this skilled and intricate assembling. When the barrel and receiver have been fitted, the action assembled, and the properly numbered stock fitted to the receiver, the finished arm then goes for its first inspection.

THE inspection-room is in charge of graduate assemblers and trained mechanical engineers. Each arm passes to several different inspectors, each having a particular part of the rifle to examine. If the arm passes its first rigid inspection it is then sent to the gallery for firing. Like all visitors at an arms plant, the sergeant's weary footsteps quickened at the report of Hi-powered rifles and his head came up like a hunting dog's, with the odor of burned powder. We watched the first interesting process of testing the rifles in steel boxes for safety and then watched the marvelous skill of expert shots in aligning sights and inspecting fired cartridge-cases. They must find any defect in the fit of the cartridge to the chamber, such defects being made apparent to them by the slightest bulge in the case, or by traces of powder marks. Critical inspection here sends back to the assembler a rifle that has the faintest defect in firing. He must correct the defect and bring that particular arm back for supervised firing before it is passed as a perfect arm.

LOADED on trucks, the finished arms are taken to an elevator (on which we were grateful to ride) and sent to the packing-and-shipping-rooms. In the packing-room each gun is carefully covered with a coating of special non-running grease. The barrels are carefully coated so that every exposed surface is protected against moisture, for several years storage if necessary. They are then sent to the shipping department, where every rifle is packed in a special individual carton. This individual packing insures delivery of the arm to the customer without unnecessary handling and danger of breakage in transit. As we stood on the shipping-platform reading the destination of cases of rifles that were going from near-by Adirondacks to far-off India and Australia, my mathematical friend, the sergeant, was still trying to figure out how many different operations he had seen during the day that were necessary to produce the finished Model 99 rifle. His guess was still so far short that I had to tell him he had looked at some 800 classified operations during the day . . . at which he remarked that no wonder he was tired.

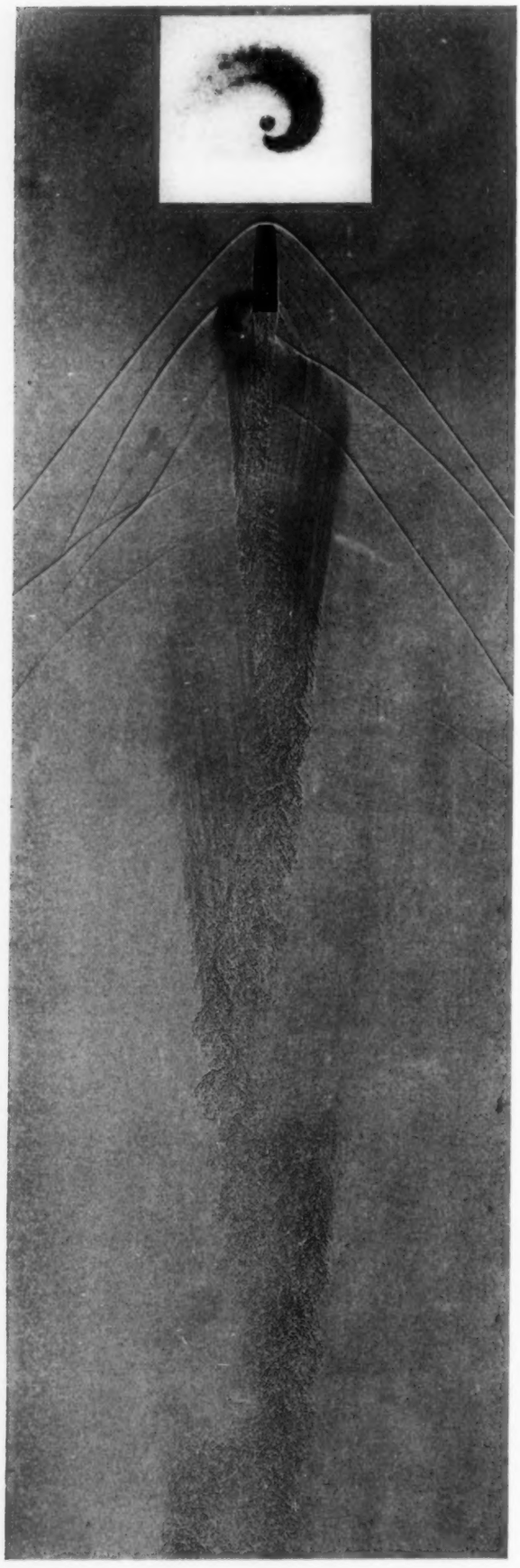
My companion came out with a new feeling of security and confidence in the average rifle. He had taken it for granted that a rifle was just made and had heard stories of rifles that shot loose and had occasionally had experience with defective arms. He, like the average layman, had no idea of the skill, science, and relentless accuracy involved in the turning out of Hi-power rifles. Certainly you may be sure he will have a more friendly attitude toward his shooting-piece than he has ever had before.

On our way back to the factory office a stop was made in that mysterious part of every firearms plant known as the experimental department. A large "No Admittance" sign on the door indicates the mysterious goings on that are taking place in the never ending experiments in the design of firearms and the development of Hi-power rifle cartridges.

My Army friend was shown the fascinating experiments of taking Hi-power rifle-cartridge ballistics with a chronograph, and told of the many famous productions that had emerged from this experimental room. The development of those famous rifle-cartridges, the .22 Savage Hi-power and .250/3000 Savage, which were the pioneers in Hi-speed cartridges, is a story in itself. It is enough to say that the making of a Hi-power rifle is only part of a manufacturer's activities. He must watch continually the performance of the cartridge chambered for his rifle and must strive for the highest possible results. For the full capacities of a finely turned rifle barrel can only be brought out by the perfectly balanced ballistics of its cartridge.

IN discussing the varied human elements that enter into all manufacturing plants, my investigating friend, who has visited many modern manufacturing plants, found an interesting phase in this work when he was told that many of the men operating on the most intricate pieces of firearms production have been Savage employees for twenty or more years.

These obscure men whom the public never meets are the real operators of the business. High executive officers come and go, and their varied interests lead them away from the time-honored pride of a personally finished piece of work that was characteristic of our early American manufacturers. This pride of workmanship, however, still exists among the old employees in many of the Eastern manufacturing plants, and it is to the credit of these skilled workman that the high quality of the products is carried on to continual betterment based on years of experience. The same is true of the various Government arsenals and establishments, where devoted employees, often in the second and third generation of the same family, continue with consummate ability and skill to maintain and improve the high quality of our service weapons.



An Unusual Bullet

By Philip P. Quayle*

THE accompanying spark photograph shows a .25-35 Soft Point bullet fired from a rifle whose barrel was 26 inches long and the pitch of the rifling was one turn in eight inches. The first ten inches of the lands and grooves of the rifling of this arm were almost worn away and the bore was quite rusty. It had apparently been greatly abused when submitted for test. The muzzle speed of this bullet was approximately 2,000 feet per second and the point at which this photograph was taken was roughly 20 feet from the muzzle.

When such a bullet is fired under ordinary circumstances from a rifle, the barrel of which is in good condition, the lands, or raised portions of the rifling, are forced into the metal jacket as it leaves the mouth of the cartridge case. Thus, its rotational acceleration increases directly with its acceleration along the bore when the rifling is of constant pitch. However, in this case the bullet moved through the first ten inches of the eroded portion of the barrel, in which the rifling was worn away, acquiring little if any rotational speed but a relatively great speed along the trajectory. Hence as the bullet entered the portion of the barrel in which the rifling still remained, the lands suddenly cut into its jacket and its rotation was violently accelerated, the shearing action being sufficient in this instance to puncture the bullet jacket. The heat thus generated together with that of the friction of the rusty bore was sufficient to melt at least a portion of the lead inside the metal jacket.

Due to centrifugal force, some of this molten lead issued from the aperture previously cut in the bullet jacket, in the form of a small stream. As this small jet of molten lead encountered the slip stream of the atmosphere through which it was passing, it was broken up into very minute particles, each of which continued for a time to generate its own sound wave and wake as shown by the many parallel lines in the shaded portions of the bullet wake in the photograph.

Thus the bullet moved forward throwing out a finely divided spray of molten lead much in the manner of a pin-wheel moved in a direction at right angles to its plane of rotation.

The bullet itself does not follow the spiral of the lead spray, although it is probably forced to oscillate slightly about its trajectory due to the reaction of the lead spray which issues from the fractured jacket. The wake of the bullet immediately behind its base seems to bear this out. Due to the gyroscopic action of the bullet its instantaneous motion at a given point is not in the direction in which it is urged by the force due to the reaction of the lead spray but at ninety degrees to this direction. Thus the trace or wake of the lead spray should be not one hundred and eighty degrees from that of the bullet wake but only one-half this amount. The center of gravity of the bullet and spray system will trace out a smooth curve in space.

Approximately four feet farther along the trajectory from the point at which this spark photograph was taken, a sheet of paper was so placed that it was pierced by the bullet. A photograph of the original pattern of this particular bullet is reproduced with the photograph. It will be noted that the lead spray in the immediate vicinity of the bullet retained sufficient velocity to pierce the paper while that farther out, reduced in speed, was barely capable of marking the paper.

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The Service Pay Situation

The Present Economic Status of Army Officers

ARMY officers' pay has been a much discussed question since the World War. The present pay law was made effective in 1922 and the question is again before the Congress for consideration. The accompanying article will be of interest to all members of the Army Ordnance Association, particularly those in civil life, because it presents in a convincing, plain-spoken manner the apparent inequalities between the remuneration received by Army officers and that of individuals with similar responsibilities in industrial and professional fields. The contrast is all the more apparent in the case of ordnance officers whose duties are of a highly specialized engineering nature.

While a departure from the usual type of article presented in this journal, the problem is of such vital concern as to merit general consideration leading, we hope, to appropriate remedies. It involves not only the morale of the Army but, what is even more important, justice and fair play for a group of citizens who, having devoted their lives to the military service, are compelled to live under severe economic hardships. For obvious reasons the author, who is an officer of the Ordnance Department on duty at one of the larger arsenals, will remain anonymous.

THE EDITORS.

THIS paper makes a brief general economic study of Army incomes and standard of living in 1928-1929, suggests a remedy for present unsatisfactory conditions, makes a few pertinent comparisons of the effect of present conditions on Army officers as a class and ends with a brief account of the personal economic experience of the author, which, while it may sound like a hard luck story and a "horrible example" is believed to be typical in a general way, though differing in detail, of that of other officers. There is no doubt that others can evolve much more harrowing tales of economic woe than the author, as there are many officers less fortunately affected by the present pay act than he.

The effect of present economic conditions in the Army has not yet manifested itself in a marked lowering of the standard of applicants for commission as nearly as I can judge from rather limited personal observation. It has, however, had a marked effect in lowering the morale of officers now in the service, many of whom are smarting under a feeling of injustice, discouragement and inferiority as a result of lowered comparative economic standing in the community. It is only a question of time, however, until economic laws will operate on the Army the same as they do on other activities, and instead of being able to select above average men for officer material as we do at present we shall find ourselves with nothing but the incompetents, misfits and left-overs that cannot succeed in the competition of modern industrial life. If such a condition comes to pass the country will pay dearly in blood and treasure for its mistaken economy in the event of another war.

I feel that the economic troubles of Army officers cannot justly be laid to the faults of Congress. Congress in passing the present pay act gave the Army what it thought it wanted. The trouble was lack of clear thinking and timidity in the Army itself. Let us hope that we get some clear thinking this time, and that the situation is not muddled by too many special cases and personal considerations.

There may be some slight errors in numerical computation in the figures quoted in this paper, but it is believed that the statements are substantially correct, and authority is quoted for every statement made that is not based on the author's own computations.

IN 1908 Congress passed a law establishing a schedule of pay for officers of the Army which provided a simple, logical, easily understood and adequate system of compensation. The rates of pay prescribed by this act were satisfactory to the Army at that time, and were not considered high compared to the remuneration paid for similar services in civil life, in fact, were well below the latter.

Since 1908 the cost of living has risen 81 per cent, as shown by the following index numbers of the cost of living computed by the U. S. Bureau of Labor Statistics:

1908—Index No. 91—Purchasing power of the dollar in terms of the 1908 dollar, $1.00.

1913—Index No. 100—Purchasing power of the dollar in terms of the 1908 dollar, 89 cents.

1927 (December)—Index No. 163.6—Purchasing power of the dollar in terms of the 1908 dollar, 55 cents.

There is no hokum or mystery in the above figures. It is a matter of common knowledge that the dollar today purchases only slightly more commodities and services than fifty cents did in 1908.

In 1922 the present pay act prescribing rates of pay for the military and quasi-military services was passed. This act is so complicated and involved that it becomes difficult to determine just what increase in compensation the average Army officer has received by its provisions. The average increase has been computed, however, by two different methods, and the close agreement between the results of the computations indicates that a figure of 18 per cent is substantially correct for the average percentage increase in Army officers' pay. First method: divide the total appropriations for pay of officers, increased by the value of quarters, heat and light, for 1917 by the total number of officers in the Army in 1917 we get the average pay in 1917 ($3,787); doing the same thing for 1928 ($4,488), dividing the difference of the two by the average for 1917 gives 18.5 per cent for the average increase. Second method: compute the average percentage increase in pay and allowances of each grade of officer, multiply the percentage increase by the percentage of officers of that grade in the Army and add the results, which gives 17.73 per cent for the average increase.

WHEN a rise in the cost of living of 81 per cent is only partially compensated for by an increase in compensation of 18 per cent either one or both of two events occur: (1) the officer goes in debt; (2) his standard of living falls. Both of these things have happened to most Army officers. The amount of debt an officer can incur and carry is of course limited, and when he reaches the limit the only recourse he has is to reduce his standard of living. *The present standard of living of the average Army officer is now one-third lower than that of 1908.* Since the 1908 pay schedule only provided for a comparatively modest standard of living a cut of one-third in the 1908 standard has not only been a real hardship on officers but has given them a sense of inferiority and lowered morale. This feeling has been added to by the contrast between their economic condition and that of persons in civil life. The United States has been enjoying a period of unexampled prosperity and the highest average standard of living ever seen in the history of the world.

American wage-earners have made, since 1914, the following percentage gains in standard of living (figures are for 1927):

Industrial wage-earners	36 per cent
Building trades	33 per cent
Anthracite coal miners	56 per cent
Railroad employees	59 per cent
Agricultural workers	some increase

The above gains have been accompanied in most cases by shorter weekly working hours.

For the middle class American such definite figures are not available, but it is apparent to any observer of contemporary American life that corresponding gains have been made by this class. The enormous quantities of high grade automobiles and other expensive goods that are being bought by Americans, the increase in the number and membership of country clubs, the annual influx of visitors to California, Florida and other national playgrounds, the half million Americans who visit Europe each year, are but a few of the indications of prosperity of the middle class.

The Army officer asks himself why some of the prosperity is not coming his way, and the only answer that suggests itself is that the profession of arms is more or less obsolescent, and that his services are therefore not considered as valuable to the community as they were in 1908. Such a thought is depressing to one who has devoted his life to the service, and leads to discontent and lowered morale.

THE Army officer would like to be restored at least to his 1908 standard of living, and might legitimately ask to enjoy some of the improvement in standard of living that has been gained by the country at large since 1908. As a matter of justice officers should also receive from the United States a lump sum payment or bonus to compensate them partially for the financial hardships they have endured during the ten lean years that have just passed.

The Army officer does not want the present muddle-headed 1922 pay schedule with its complicated, discriminatory socialistic features that penalize one class of officer and reward another, or any modified form of this schedule.

The remedy proposed is simple. Take the 1908 schedule of pay and allowances, increase the amounts 80 per cent to make up for the rise in cost of living since 1908, and take the nearest even amounts (in hundreds of dollars) as the new annual rates of pay. This will do no more than restore to the Army officer the standard of living he enjoyed in 1908.

This has been done in the accompanying table, using heat and light allowances for Washington, D. C., which are about an average for the country, and lumping allowances with pay, since they both together constitute compensation.

While the amounts given in the following table may appear large they do so only because we are accustomed to think of a dollar as a dollar. If we call the present dollar fifty-five cents, which it is in purchasing power in terms of the 1908 dollar, the above pay schedule becomes merely that of 1908 in present purchasing power. Real income not money income is the important thing as is generally realized by all intelligent people today.

The effect of the Government's paying Army officers in 55-cent dollars has been equivalent to laying a heavy direct tax on this class of citizens. The average compensation of Army officers in 1917 was $3,787 under the 1908 pay schedule. Increasing this 80 per cent to keep pace with the rise in living costs, he should have received $6,796 in 1928. He actually received only $4,488, the difference, $2,308, being collected by the Government by the simple process of retaining it. By short changing Army officers (and other Government employees) in this way the Government has been able to reduce taxation, shifting the burden from the bulk of the population to Government employees. This has made available a surplus that could be applied to the reduction of the national debt.

The national debt, which amounted to 26.5 billions in

PROPOSED PAY SCHEDULE

Rank	Initial Rate	5 Years Service	10 Years Service	15 Years Service	20 Years Service	To be Deducted from pay when Quarters are Furnished in Kind
2nd Lieutenant	3,700	4,100	4,400	4,700	5,000	800
1st Lieutenant	4,600	5,000	5,300	5,700	6,000	1,000
Captain	5,600	6,000	6,500	6,900	7,300	1,300
Major	7,000	7,500	8,100	8,600	8,800	1,600
Lieutenant Colonel	8,200	8,800	9,500	10,000	10,000	1,900
Colonel	9,400	10,100	10,800	11,200	11,200	2,200
Brigadier General	13,300	.....	.....	.....	.....	2,500
Major General	17,200	.....	.....	.....	.....	2,800

1919, was reduced 1.2 billions annually during the period 1919-1923, or $10 per capita per annum for the entire population of the United States. When $10 per capita is compared with $2,308 per capita that is collected from Army officers it appears as though the latter were more than doing their share.

And this situation has kept up for ten years now, during which time the Government has collected on an average $23,000 from each Army officer. A major general has been mulcted over $76,000 during that period by this system! No wonder we are poor, shabby and harassed.

THE German people is supposed to be groaning under an intolerable burden of reparations payments, if we may believe what we read in the papers. Perhaps groaning is too mild a term, howling would be better. The maximum annual payment of 595 million dollars amounts to less than $10 per capita for the population of Germany. What Army officer would not rather pay the average German's share of reparations than his own tax for winning the war and making the country prosperous?

Socialism is defined in simple terms by its exponents as "Equal incomes for all." This ideal has never been attained on a large scale anywhere in the world, but is that towards which socialists are striving everywhere. The nearest approach to equality of income has probably been reached in Soviet Russia, but even there some difference in rates of compensation of workers for differences in skill and managerial ability has been found necessary in order to carry on efficiently.

In Russia all industrial workers are divided into seventeen categories, the first ten being manual workers and the other seven managerial and sub-managerial workers. The highest managerial position is paid about twice as much as the highest paid manual worker, who in turn receives four times as much as the lowest paid unskilled worker. The ratio of average managerial pay to that of the average manual worker is about three to one.

In the United States, at present the most capitalistic and individualistic country in the world, we should expect to find a much higher ratio of managerial pay to laborers pay, and we do so find it in industry. However if the average income of Army officers ($4,488) be compared to that of industrial workers ($1,309 for 1926) the ratio is found to be 3.4 to 1, only slightly greater than the Russian ratio.

The Army has apparently been socialized rather successfully.

The Army has borne this burden for ten years now without raising much stir about it for three reasons: First, the average officer is loath to complain no matter what his troubles, and to complain because of money troubles is particularly distasteful to him. Second, while he knew vaguely that something was wrong he did not realize just how badly off he was. Third, he realized that economy in governmental expenditures was necessary in order to put business on its feet again and restore prosperity, and he was willing to bear his share of the economy program. The last two reasons no longer exist. The Army officer has learned where he stands. Business is booming. It is time the pay were raised and raised adequately. If the total cost is found too great for the country to pay reduce the size of the Army accordingly. Industry has frequently found that increased wages result in increased production and lowered costs due to better quality and morale of workmen. The principle may apply equally well to the Army. Since we have only a nucleus of an Army anyway quality is more important than quantity, and we shall not get quality and morale with our present rates of pay.

COMPARING the present to the period before the World War I can say that I do not enjoy one-half the comforts as a major (age 40) today that I did as a second lieutenant (age 24) before the war. I live in a smaller, less comfortable house in a much less attractive environment, wear clothes of inferior quality and have fewer of them, have less luxuries in the way of food, have less money to spend on recreation and amusements and have to do for myself most of the menial tasks that I used to hire others to do. With the exception of two brief periods of a few months each I have never been out of debt during the past ten years.

Practically all my spare time during the past year and a half, including at least a half day every Sunday and holiday and such short periods of leave as I have taken, has been taken up in some sort of household drudgery. (I was even warned by the police on one occasion not to work on Sunday as it was against the law.) During the same period of a year and a half my wife has worked continually at cooking and housework without a day off.

As for personal expenditures, I run on a strict budget, and get $20 per month for my personal expenses including clothing, both civilian and uniform, personal toilet articles, tobacco, dry cleaning, amusements and other personal expenses. The private soldier has that much for the same purposes, and in addition is furnished his uniform clothing. Needless to say I have tried to figure out some way to get more spending money for myself, but just can't seem to manage it on my present income. I have not purchased a new suit of clothes for over two years. I had to buy a civilian overcoat this year (the one I had been wearing was seventeen years old) and was compelled to go to the expedient of the partial payment plan in order to pay for it. My present civilian evening clothes are of the vintage of 1911, worn and shabby, and have needed replacement for several years, but I do not see where new ones are coming from in the near future. It is true that clothes do not make the man, but equally true that shabby, cheap clothes do not improve the man's morale.

My wife is no better off as she gets only $25 per month for her own personal expenses. She has not bought a new dress or coat for over two years, and were it not for gifts of clothing from relatives would be in a decidedly bad way.

My two children have also been assisted by gifts of clothing from relatives.

After six years service in my present grade (from 1922 to 1928) I have received one increase in pay of $150 per year. Where in these United States is the industrial or business concern that can hold its executive and administrative personnel by any such long delayed and insignificant increase of salary? It can't be done even in the Government civil service.

I have no cash savings. Such savings as I possess are in the form of life insurance (most of which is pledged for policy loans) and an equity in the house in which I live. Buying a house seems to be the only way in which the system can be beaten a little. By making a small cash payment a house can usually be purchased for monthly payments that do not exceed the amount for which it may

be rented. My method is to borrow enough on a life insurance policy to make the cash payment; the monthly payments then increase the equity, and if I am fortunate enough to sell the house at somewhere near its cost price when I am ordered to a new station, I save a little money by the transaction.

Changes of station, which occur on an average every two years, have always necessitated the borrowing of money and handicapped me financially for from six months to a year after each move, besides the difficulty of adapting oneself to a new environment.

Were it not that it would be practically impossible to attend to my official duties without a motor car the probabilities are that I would dispense with one. My system is to borrow enough money on my Government insurance policy to buy the lowest priced car on the market, making repayment to the Veterans' Bureau by a standing allotment of pay of $20 per month. By the time the car is worn out the loan is repaid and the process can then be repeated. Logically, however, the ownership of even the lowest priced car is an undue strain on a person of my economic status, and were it not a necessity in this day and age, and for the particular conditions of my present assignment, I would do without one.

Not living on an Army post I am subject to local taxation, and receive direct tax bills for no less than eight different local taxes (auto registration, auto excise, drivers' license, real property, personal property, water, poll and special street improvement assessment). My annual payments for interest and taxes last year totaled $687.52. Before the war direct taxation never touched me.

Officers are allowed one month's leave per year with pay. The purpose of a vacation is generally supposed to be to get rest and recreation, preferably with a change of scene and environment. My leaves of absence of any length of time since the war, have, with one exception been spent at home, as I have never had the necessary surplus funds to be able to go anywhere for a vacation. The one exception was a leave of one month and twenty-five days spent in automobile touring, and this was made possible only by the facts that I was changing station and that I camped in so-called "tin-can tourist" style instead of putting up at comfortable hotels. On this leave I did come out even financially, and incidentally enjoyed the camping, though I can't say that my wife did.

I append my present monthly budget of expenditures, which is somewhat different from the one I have been living on for the past six months, as cuts have been made in the amounts of the personal allowances and some other items to enable the employment of a servant. Only time will tell whether it will work out. I have a hunch that there is insufficient margin of safety in it, and that the servant will have to go, but hope not as I am thoroughly fed up on dishwashing, house cleaning and similar chores.

Monthly Budget—Major, 21 Years' Service—Pay $491.50

Personal allowances:	
Officer	$ 19.00
Wife	22.00
Son (15)	13.00
Daughter (8)	13.00
Shelter:	
House payment	70.00
House repairs	5.00
Taxes and fire insurance	15.00
House furnishings	9.00
Fuel and light:	
Coal	10.00
Electricity	4.50
Gas	9.50
Subsistence:	
Food	117.00
Ice	4.00
Garden (vegetables and flowers)	5.00
Protection and savings:	
Life insurance	70.00
Culture:	
Books, magazines, etc.	4.50
Cleanliness:	
Laundry	22.00
Communications:	
Telephone	3.75
Transportation:	
Car operation	15.00
Service:	
Servant	50.00
Unclassified:	
Miscellaneous	10.25
Total	$491.50

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Index to Army Ordnance, Volume IX.

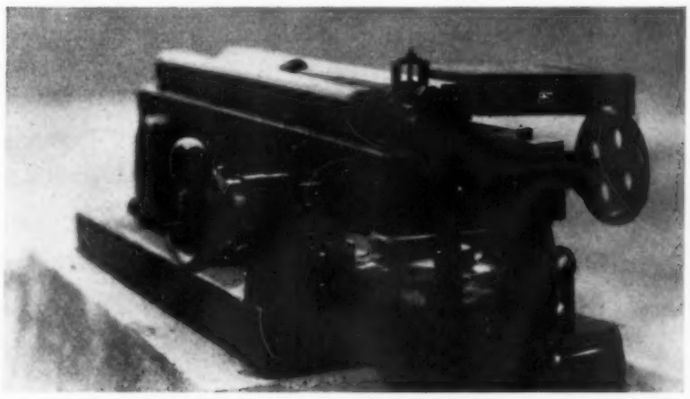
THE May-June issue of Army Ordnance *completed Volume IX. An index to Volume IX, arranged alphabetically by subject and author, including title page for binding, is available for members and subscribers and may be obtained without cost from the editorial office of* Army Ordnance. *Readers who are having the journal bound for permanent record will want the index and title page for this purpose. Requests for copies will be handled promptly and should be addressed to: The Editorial Office, Army Ordnance Association, Mills Building, Washington, D. C.*

The Mastery of Metal Fouling

The Development of Lubaloy for Rifle Bullets

By R. F. Riggs*

THE development of the small-bore military and sporting rifle using a bullet with a jacket or mantle of metal other than that forming the core, brought about many problems that had not previously confronted either the arms maker or the ammunition maker. For the same inexplainable reason that many other things have been done in the ammunition industry, the first attempts at jacketing a lead bullet were made by using either cupro-nickel or mild steel mantled with cupro-nickel. From the standpoint of manufacture this method of covering the lead bullet so that it would withstand the higher velocities desired was not altogether unsatisfactory. There were, of course, difficulties in the manufacture of cupro-nickel and there were some objections to it in some quarters for other reasons, but from the outset it developed one fault from the consumer's standpoint that was not only extremely aggravating, and, in some cases actually dangerous, but that also reflected upon and retarded to a certain extent, the development of the small-bore high velocity idea.



Instrument for Determining Angle of Departure. Used at Quantico Ammunition Test, May, 1922.

This trouble was metal fouling. It is generally considered that metal fouling, in the true sense as applied to small arms, is evidenced to the eye by the presence of drops of metal that appear like drops of solder firmly welded to the top of the lands at a point generally within six inches of the muzzle. As to what causes it some authorities differ. It may be a product of friction resulting in substantially the same effect that is found when a rubber eraser is passed quickly over a sheet of paper, namely, an actual abrading away of the relatively soft material and its adhesion to the relatively hard material. It may also be due to a condition that develops in artillery known as fringing; in other words, the metal displaced incident to the engraving of the bullet jacket by the lands and grooves must go somewhere. If it is actually torn off it is probably done so in the form of foil. Due to the high temperature involved, the particles of nickel foil, although nearly microscopic in size, will accumulate into particles that are quite visible to the eye and upon cooling will adhere to the bore in identically the same way that solder would.

During the four years of the World War, during which period the Western Cartridge Company was engaged in the manufacture of military ammunition of several types, metal fouling and the necessity for removing it from the bore of rifle caliber machine guns and infantry weapons caused not only inconvenience but a knowledge that the weapon itself was being unduly worn incident to the removal of the metal fouling. A test conducted in our laboratory some time in 1919, if the author's memory serves correctly, indicated that in the quantity of standard Government fouling solution which could be contained in the bore of the Model 1903 service rifle, approximately two milligrams of free iron was found after that solution had been in the bore of the rifle for twenty minutes. There was only one place that it could come from, namely, the action of the metal fouling solution on the steel of the barrel. The test was repeated and the same results found, proving the point conclusively.

IMMEDIATELY after the close of the World War the Ordnance Department undertook to revive the military ammunition trials that had been held prior to the war. One of the purposes of the revival was to improve the accuracy or the dispersion of our military cartridge. The several ammunition companies were given practically free rein, being limited to pressure only. No restrictions were placed on the weight or type of bullet or velocity developed. Here was an opportunity that executives, ballistic engineers, chemists and metallurgists in the Western Cartridge Company welcomed. They agreed to go into the ammunition test and an appropriation of no small size was set aside for that purpose. Bullets made in accordance with match ammunition specifications and varying in weight, profile and composition were brought through in considerable quantity. Each variation, irrespective of what it was, had several types of jacket. One was standard Government cupro-nickel, another an alloy of a higher percentage of copper incorporated in some cases with zinc, in others with nickel and in others with tin and one sample with copper, zinc and tin. This sample, which was marked X because its composition in the percentages used was not previously known, consistently and from the start showed the best results in accuracy. Where other samples gave characteristic cupro-nickel fouling or long streaks of copper in some instances from throat to muzzle, this sample alone showed a complete elimination of drops and only the faintest kind of a trace of copper. Naturally, all the other jacket materials were abandoned and results concentrated on this one sample. .

*Western Cartridge Company, East Alton, Ill. Captain, Ordnance Reserve, U. S. Army.

The metal was exceedingly difficult to manufacture. The difficulty was overcome, however, and in time for the Western Cartridge Company to settle upon and manufacture a caliber .30 170 grain flat base bullet with a 7.62 Russian head. This ammunition was taken to the Ordnance Department trial held at Sea Girt in the early spring of 1920. Those who were there at the time will doubtless recall the date because it was exceedingly windy and quite cold. As the firing progressed members of the Ordnance Department Board noticed that the Western Cartridge Company representatives were not availing themselves of the interval allowed for doping; neither were they applying any lubricant to the cartridges before insertion into the chamber. In reply to a question as to the why and wherefore of this strange procedure, a prominent member of the Board was advised that we did not have any metal fouling and did not expect to have any.

Things began to happen very quickly. The members of the Board descended on us with gages, brushes, glasses and much comment. As the firing progressed and it was noted that we were holding our own against the veteran ammunition makers who finally won the test by a small margin, the thought developed that our statement in regard to metal fouling was not only absolutely true, and if we actually knew what we were doing and had not hit on to something accidently, that we had brought out a development that was of even greater importance than the increase in accuracy shown.

We were not astonished two or three years later upon being advised that an ammunition manufacturer of international scope was now producing a bullet jacket material practically identical to our recently named and patented Lubaloy, the name being a derivative of lubricating alloy. In the summer of 1920 at the National Matches at Camp Perry, a young rifleman, now a medical officer in the U. S. Army, fired the first possible score that was ever fired in the historic Wimbledon Match, using this same 170 grain Lubaloy-jacketed flat-base bullet. It was only fate that caused him to lose the match a few hours later by a score that beat his by one point.

AS manufacturing progressed and it was found that velocities could be increased without the old fear of metal fouling other means were sought to supplement the advantages already given by Lubaloy. Once more the Ordnance Department Ammunition Test proved the incentive. At the test in 1922 a bullet was submitted with a body which broke away from the parallel at the base from a diameter of approximately .3085 to a diameter of approximately .290 in about one caliber of length. We called it a boat-tail and once more smiled inwardly to note the old veterans of the ballistic station at Daytona who had been firing thousands of rounds of boat-tail ammunition, open their eyes in astonishment to think that anyone would have the temerity to submit a boat-tail bullet at an accuracy trial. Nevertheless, when it was all over this makeshift boat-tail had accounted for itself in a very creditable manner indeed. It had proven conclusively and to the sorrow of our representatives, that it had a considerably higher point of impact than did flat base ammunition at a thousand yards. Those who were present at Quantico in 1922 will doubtless recall one test in which flat base and boat-tail bullets supposedly were mixed. The flat base went into the target where the previous ones had gone and the boat-tails went over the top.

We were in close touch with the trend of ammunition developments abroad. First one and then another of the bullet makers on the Continent were bringing out certain ultramodern types of ammunition with boat-tail bullets. It seemed only logical that the development would eventually be demanded in America in sporting ammunition. It was also noted that the Continental developments were invariably being supplied with copper alloy jackets where previously they had been nickel mantled steel, copper mantled steel or cupro-nickel. We understood that one of the most influential but conservative of European governments was about to adopt a metal substantially identical to Lubaloy for its military rifle caliber ammunition. Wishing once more to offer American sportsmen the last word in an important development, we brought out the first boat-tail sporting bullet ever manufactured in America, the .30'06 180 grain. Its reception was instantaneous and its popularity deserved. Demand for other sizes came in rapidly. The new bullets were more expensive to manufacture, for various reasons, not the least of which was the Lubaloy jacket. But assuring themselves that volume would take care of this requirement the Western Cartridge Company in 1924 decided to boat-tail all sporting cartridges that could be boat-tailed satisfactorily. Once more we met a number of obstacles. Some bullets that had a very short bearing could not have that bearing reduced farther; others with a longer bearing could have it reduced considerably. Fortunately, and practically without exception, the most popular sporting cartridges could be so changed.

The old .30-30 Winchester was among them and a 170 grain boat-tail bullet was manufactured that by virtue of the reduction of barrel friction gave us a little more velocity with a little less pressure than we had ever been able to obtain before, yet the same weight of bullet was used. It likewise gave us a little greater bullet length which was commendable from the standpoint of penetration and killing power.

THE tendency in modern ammunition is toward greater and greater muzzle velocity. There are many ways in which it can be obtained, some of which are impractical. A high muzzle velocity in sporting ammunition is always desirable provided it does not lead us into difficulties that would nullify the advantage.

We believe that Lubaloy and boat-tailing will go a long way toward solving some of these problems as they arise in the future and we do not believe that it is beyond the realm of possibility that the next few years will show sporting cartridges over .250 in caliber handling bullets over 150 grains in weight and at considerably increased muzzle velocities. There will be no metal fouling and there will not be excessive pressure. Improvements are continually being planned and if apparently feasible, considerable sums of money are continually being spent on their development. The Western Cartridge Company acknowledges a debt of gratitude to its staunch and loyal friends in military and civil life who have given the benefit of their years of experience, constructive criticism and helpful coöperation, and we hope sincerely that it will always be so.

An Opportunity for Patriotic Service

A Message From the President, Philadelphia Post, A. O. A.

By Philip H. Gadsden*

THIS is the first opportunity I have had to say to the members of the Army Ordnance Association how greatly I appreciate the privilege of being President of the Philadelphia Post, and how highly I value the opportunity for patriotic service which it offers. Each one of us is a member of a large number of business, social and political organizations and we give to them generously of our time and means. The Army Ordnance Association furnishes one of the few opportunities for each one of us in peace time to demonstrate our loyalty to our Government and our devotion to its principles and institutions.

The Army Ordnance Association is a national association organized for the purpose of preparing the United States industrially for war as the best guarantee of peace. All men and women who love their country earnestly desire peace. Any differences which may exist between them are not as to the object to be attained, but as to the means of securing it.

The principle of preparedness is deeply rooted in our business, social and religious life. In industry, a management would be justly condemned which did not prepare against the inevitable breakdowns in plant and equipment by furnishing excess capacity and spare parts. In the field of public health, sanitary laws are enforced to ward off epidemics, and school children are given injection to protect them against such diseases as typhoid, smallpox, diphtheria ,etc., and to enable them to resist the attacks of these diseases in case sanitary regulations prove ineffective. In Sunday schools all over the country those great moral principles which go to make character are instilled into the minds of the children of America to prepare them to withstand the temptations and pitfalls of mature years.

HOW much more important is it that collectively as a people we should take what steps are necessary to our protection and to the preservation of our principles and institutions. The memories of the World War are already growing dim. Its lessons are fast being forgotten—the human sacrifice, the tragedies in thousands of homes, the disruption of business, the frightful economic losses, the lightless nights and the meatless days. We are in danger of being lulled into a false sense of security by earnest but mistaken men and women who tell us there will be no more war. Our answer should be—we will join with you in every movement to remove the causes for war, to promote friendship and sympathetic understanding between all nations, but if in spite of all our efforts to avoid it, war should come, we propose that this Nation shall be industrially prepared.

Through the League of Nations, The Court of International Justice, the Kellogg Treaty outlawing war, through the constant efforts of diplomats, the governments of the world are united in their efforts to remove the causes for war. War is a malignant disease which has preyed upon and devastated the human race throughout its history. It is the first duty of any government, as well as the patriotic duty of every citizen, to see to it that should all peaceful methods of arbitration and conciliation fail, this country is prepared to defend itself.

THE Government is prepared to mobilize the manpower of the United States through the Army and Navy, the National Guard, the organized reserves, the officers training camps and the military colleges of the country. But the half dozen arsenals of the United States can supply only a very small percentage of the munitions needed to make this manpower effective. American industry must be depended upon to supply the vastly greater proportion of the matériel necessary. What a great privilege and opportunity this presents to the business men of the United States. Many of us are past the age to render effective service in the event of war, but through the Army Ordnance Association the opportunity is afforded us in time of peace to render a service equally as patriotic as actual service in time of war. If we truly want to make war improbable, if not impossible, the surest way is to see to it that America is industrially prepared, for if we were effectively prepared to furnish an adequate supply of munitions and ordnance matériel, no nation or combination of nations would dare to attack us. With adequate industrial preparedness we could afford to reduce the number and size of our fighting services.

The Philadelphia Ordnance District is the largest industrial district in the United States. In case of war this district will be expected to supply about one-eighth of the necessary ordnance supplies. It is the primary duty, therefore, of the Philadelphia Post of the Army Ordnance Association to see to it that every industrial plant in this district shall coöperate fully and cheerfully with the Government. Many of them have already done so. Included among these are Baldwin Locomotive Works, Atwater Kent Manufacturing Company, Armstrong Cork Company, Leeds and Northrup, Bethlehem Steel Company, and many others, who have given freely of their time and means and engineering services to prepare factory plans. These plants know what class and type of ordnance matériel will be required of them, what schedule of production will be expected, and what tools and machinery will be necessary to guarantee this production. There are, however, many other items which have to be planned for, and many other industries will be called upon to coöperate to complete the program for the Philadelphia District.

I am confident that Philadelphia, which has responded so loyally and enthusiastically to the call of our Government in every war in which this country has been engaged, will welcome the opportunity to render this great patriotic service in time of peace.

*Address delivered by Mr. Gadsden, President, Philadelphia Post, A. O. A., at a meeting of the Post, June 10, 1929.

ARMY ORDNANCE

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Month by Month

Our Small Arms Industry

THE approach of the National Rifle Matches to be held under the auspices of The National Rifle Association at Camp Perry, Ohio, during August and September is fitting occasion for some tribute, however slight, not only to American pistol and rifle shooters but likewise to the small arms industry of the Nation—the designers and manufacturers of small arms powder and ammunition, pistols, rifles and shot guns, sights and other accoutrement of the rifleman.

It is a happy state of affairs to have throughout our land that vast family of shooters which annually attends the matches. Since they are but a small percentage of the many there is cause for even greater congratulation to the thousands who, through interest in the sporting element of target shooting, are keeping alive this manly art. Thanks to the National Rifle Association and its capable officials, interest in small-arms shooting continues among ever increasing numbers.

But it is not to the riflemen themselves to whom we would pay particular tribute here. Rather do we single out that essential industry which since the days of Whitney and North has been producing, often at considerable odds, the rifles, pistols and ammunition that have won for America high place in the art. It is an auspicious sign, we believe, to have so highly specialized a group in our midst. It is beyond doubt a most essential link in a great and weighty chain that binds our national defense system to reality. And more than that it is an unique group in this, that it continues to improve its product in a day when flabby-minded souls wonder at the need of the seemingly barbaric implements thus produced. Thanks to a fine sense of business judgment, the industry has diverted some of its capacity to the production of peaceful machines for which there is greater demand. The fact remains, nevertheless, that our small arms producers continue to supply the increasing requirements of the shooters in a most satisfactory manner.

So we say that there is reason to be proud of our American small arms industry—the men behind it and the things produced. May it be no vain hope that the coming matches will disclose not only an increase in ability on the part of marksmen but a growing demand among people generally for the efficient products of the small arms makers. After all, upon the healthy condition of both depends in great measure the possibility of America—if she ever arms again—having in her van the spirit of the pioneers, the dependability of the crackshot and the perfection of rifle and shell—all of which mean for him who goes to battle a cause well nigh won at the start. Happy the nation able to boast of these modern day vigilantes..

Greetings To Doctor Munroe

FIFTY-EIGHT years of unusual accomplishment in educational, scientific and industrial fields is the exceptional record of Dr. Chas. E. Munroe, dean of American explosive chemists who, on May 24, 1929, celebrated his eightieth birthday in Washington, D. C. Born at Cambridge, Mass., Dr. Munroe was graduated from Harvard University in 1871, later obtaining his doctorate degree at Columbian (now George Washington) University. He was assistant professor of chemistry at Harvard from 1871 to 1874, professor of chemistry at the U. S. Naval Academy from 1874 to 1886, chemist at the U. S. Naval Torpedo Station and War College from 1886 to 1892, and head professor of chemistry and dean of the Corcoran Scientific School from 1892 to 1898. During this period, from 1893 to 1918, he was dean of the Faculty of Graduate Studies of George Washington University. A consulting engineer of international reputation, he has, during his many years of service, been identified with the U. S. Assay Commission, the U. S. Geological Survey, the U. S. Bureau of Mines, the American Railway Association, the Swedish Academy of Sciences. Since 1918 he has served as Chairman of the Committee on Explosives Investigations of the National Research Council in addition to his position as chief explosives chemist of the U. S. Bureau of Mines.

Dr. Munroe has been the recipient of many well-deserved honors. He is a fellow of the Chemical Society of London and of the Society of Chemical Industries of England, a past president of the American Chemical Society. He has served as a member of four International Congresses of Applied Sciences and of the Section of Applied Chemistry of the Second Pan-American Scientific Congress.

He is a member of many technical and scientific organizations, being a charter member of the Army Ordnance Association and a contributor to this journal. To few other civilians are our national defense services indebted in the degree to which they are to Dr. Munroe. His unfailing coöperation with both the Army and the Navy has been given over a long span of years—years which have witnessed unparalleled progress in explosives development. Few if any of these developments have advanced without some advice gleaned from the vast experience and knowledge of the eminent Munroe.

To the greetings of friends and coworkers throughout the world Army Ordnance adds its felicitations and extends congratulations to Dr. Munroe who, in his eighty-first year, is carrying on his scientific pursuits with the vigor and cheerfulness of youth. May he be with us as counselor and leader for many years to come.

So Much For Frau Schwimmer

SCHWIMMERS of all kinds and from everywhere should note well that they are not wanted as American citizens. This virtually is the significant decree of the United States Supreme Court in denying citizenship to Frau Rosika Schwimmer, notorious Hungarian pacifist, who declared, while applying for naturalization, her unwillingness to take up arms in protection of her adopted country. This sound decision of our highest tribunal comes at a time when Schwimmerism seems to be riding the crest of a wave. It would appear to the casual observer that too many of our uninvited guests who decide to stay and enjoy the unfettered opportunities which America offers are not alone only half-heartedly concerned with duties of American citizenship but are averse particularly to the defense features of those duties. Our Supreme Court sounds an opportune note when it declares that one of the obligations of American citizenship is the duty to defend the land even unto death against invasion, insult or aspersion. That is an old-fashioned doctrine innately concurred in by real Americans.

Our principal concern, however, should be that Schwimmerism is not confined to our guests; there are far too many native-born Schwimmers who inherit their right of citizenship and thus have it thrust upon them. Would that the same judicial machinery were at hand by which this class could have so priceless a heritage rescinded them just as it is denied a stranger who desires it and cannot have it. Frau Schwimmer may be excusable but Schwimmerism or even indifferentism on the part of fellow-citizens is an insidious thing which demands the watchfulness and censure of all right-thinking people. Sensible folks realize that where there are rights there are duties, that if one will take the benefits he must likewise gladly assume the burdens. May the act of our Supreme Court have its lessons for native as well as foreign-born Schwimmers.

Frank W. Morse

IT IS our sad duty to record the death of Mr. Frank W. Morse, a distinguished member of the Army Ordnance Association, who died recently at his home in New York City. Mr. Morse was one of the pioneers in the development of the Canadian Grand Trunk Railway System. Born in Lafayette, Indiana, in 1864, he received his education in the public schools of his native city and at Purdue University. He served first under General Dodge with the Denver and Rio Grande Railroad and later with the Wabash Lines. In 1896 he became Vice President in charge of transportation of the Grand Trunk System. With unbounded faith in the future of Canada, he initiated the plan of extending the lines to the Pacific and became general manager of the projected extensions from coast to coast. Subsequently he was associated with the late Theodore P. Shonts as Vice President of the Chicago and Alton Railroad and the Toledo, St. Louis and Western.

During the World War Mr. Morse entered the service of his Government, becoming a member of several important committees of the Council of National Defense. From 1919 to 1925 he resided in Europe conducting negotiations with the governments of Central and Eastern Europe.

Mr. Morse was a charter member of the Army Ordnance Association, whose passing removes from our midst a distinguished executive of world-wide influence who served nobly in promoting the welfare of other countries and who, in war and peace, was intensely devoted to his own.

Our Annual Meeting

ON THURSDAY, October 10, 1929, at the Aberdeen Proving Ground, Md., the eleventh annual meeting of the Army Ordnance Association will be held with the National Aeronautic Association and the National Metal Trades Association participating. Plans are progressing for a program of demonstrations and exhibits of up-to-date munitions for the enlightenment of members of our own association and those of the participating organizations. It is also planned to have the customary technical meeting addressed by eminent speakers. The presence of the National Aeronautic Association at the meeting should offer an unusual opportunity for demonstrating to members of that organization some of the latest improvements in antiaircraft developments and at the same time we hope will present similar occasion for the exhibition of the new military aircraft. There will be much to interest the National Metal Trades Association since the metals industries are concerned with the basic materials of ordnance.

Following previous custom, personal invitations with preliminary data, including reduced railroad fare certificates, meals reservation forms and orders for accommodations on special trains, will be mailed about September 1st to all members of the Army Ordnance Association and of the participating organizations. There is every indication that the coming meeting will rank in importance with its ten predecessors and will result—as is its purpose—in renewed impetus to our cause: industrial preparedness for war as the Nation's strongest guarantee of peace.

A Leader in Peace and War

THE appointment of Alexander Legge of Chicago to the chairmanship of the Federal Farm Board brings well-deserved honor and tribute to a man whose career in peace is no less distinguished than his eminent service in war. During the World War Mr. Legge was vice-chairman of the War Industries Board and manager of the Allied Purchasing Commission. Of his service on the War Industries Board it has been said: "He filled the position next in importance to the chairmanship itself. Yet Legge, who was an active officer of the International Harvester Company, had no more than a local reputation outside his own branch of industry. Baruch knew him well and all American industry came to know him and the statement is ventured that if the Board's chairman had raked the country from Maine to California he could not have made a happier choice. Legge possessed evenness of mind in combination with a tremendous store of energy and initiative. He could plan or execute his chief's plans equally well. A tower of strength in the War Industries Board —that was Legge."

Thus another member of the Army Ordnance Association again assumes responsible leadership in the councils of state. May his service to agriculture be as noteworthy as his work for American munitions during the World War and since.

This Talk About Universal Draft in War

An Editorial

WHEN are we going to come down to earth in planning for "the next war"? On the heels of an announcement that the War Department has in preparation a bill to "draft" industry, capital, labor and what not in war, comes now discussion in the press that plans for another major conflict have in contemplation billeting our war-time armies in hotels. Will it be private bath for doughboys and bridal suites for brigadiers? Are tents to be on the black list as too lowly for soldiers of the future? Are company streets to be displaced by hotel corridors and are shave tails to have the convenience of bed-side telephones of the French variety for passing orders to the top sergeant? The imagination cannot be blamed if it thus pyramid absurdities ad infinitum. The truth is there is altogether too much wild talk making the rounds these days and particularly in connection with the so-called universal draft. It is high time, we take it, for some plain words and decisive action on the subject else fair-minded, sensible folk are going to become disgusted with the whole works, throw up the sponge, quit bothering now, wait until the next war and then see what happens. Just why a bill having a universal draft as its purpose should be in contemplation is difficult to understand.

The anticipated War Department bill has not yet been held up to public scrutiny. Until that eventful day it may not be inopportune to suggest to those who are preparing the proposed legislation and to those who are demanding such an enactment, that before all else they keep both feet on the ground lest in a moment of enthusiasm they wreck an already operating, fair system of industrial preparedness.

IT IS easy enough to incite the mob over the injustices of war. It is even less difficult when the doughboy-to-be has pictured for him the inequalities of old systems, the sacrifices of the individual and the smug security and gain of the elect. But, as in the case of most Utopian schemes, the picture is not always accurate. Hence we say, as to any new legislation in prospect, make haste slowly, be certain that new proposals are more practical than old, and above all be sane and sound.

We suspect that some will read into this admonition that we champion the cause of the profiteer as against the plight of the conscript soldier. Not at all. There have been contemptuous opportunists since the beginning of time and we have no reason to doubt that even under the best of plans they will be with us always in peace and in war. But he who would judge the many by the few is just as pitiably lacking in human experience as the fadist who would draft dollars and dynamos, donkeys and drays. It seems that the champions of universal conscription would hurl the epithet profiteer at everyone who does not shoulder a rifle but who performs the equally necessary war-time function of supplying the implements of battle. Such an insinuation is so unfair as to need no refutation.

From what we have seen of discussion on the subject we believe that the term "universal draft" is a misnomer and that "mobilization" is really meant. In that event the case is far different. The former is an impossible status; the latter, as was accomplished by the War Industries Board during the latter part of the World War, is an equitable and efficient expedient.

LET us make and plan to *mobilize* everything — men, money, materials and muskets — utilizing all to the last degree and on terms equitable to all. In this regard, Mr. Bernard M. Baruch, Chairman of the War Industries Board during the final stages of the War, has expressed an opinion which, coming from such eminent authority is well worthy of thought. He said:

"In sharp contrast to those who object on the communistic argument are those—and there are many—who say: 'Draft everything—draft dollars—draft labor—draft property. If soldiers lives are drafted at ridiculous pay—draft everything else.'

"Now you can't do these things in this way. If you take property our Constitution says you must pay 'just compensation.' Just compensation for a dollar is a dollar and drafting dollars would be futile. That same great charter says 'no slavery' and the enforced labor of any man for any private master has repeatedly been defined as slavery. You can draft men for Government service but you cannot draft labor in the sense here considered.

"As to capital a similar solution was adopted. We did not say to dollars, 'You must serve here.' We *did* say, 'You must not serve there.' That is, a Capital Issues Committee was set up and no securities were permitted to be issued anywhere in the United States until after they had been submitted to that committee. Capital can be required to confine itself to operations essential to the winning of the war. Its rate can be regulated and its effectiveness controlled. Thus, while there can be no draft of dollars, there can be an effective mobilization of dollars and anyone considering this problem must always carefully distinguish between the word 'draft' and the word 'mobilization.' The former indicates an impossible conscription of the unwilling. The latter indicates coöperation toward a common end under wise guidance and relying on persuasion rather than on force, although it must be admitted that behind the persuasion there is always the iron hand within the velvet glove.

"Of course, if the iron hand has to be generally applied it simply means that the nation is not at one with the war and no nation in that condition ever ought undertake a war and certainly never will win one.

"Thus between the extreme drafters of everything and the extreme advocates of no control at all, I have heard no better plan than the wise, moderate and peculiarly American plan of passing the nation's problems back to the people of the nation to solve by coöperation and self-sacrifice which was adopted by the war government of the United States in the World War."

Here is sound reasoning. Opposed to it is the communistic complex that would draft everything in sight. The two are diametrically opposed. The right solution will be found in coöperation—not compulsion.

Books

The Turning Point of the Revolution. By Hoffman Nickerson. New York: Houghton Mifflin Company. $6.00.

BURGOYNE, Carleton, Gates, Sir Henry Clinton, St. Clair, Howe, Germaine, Vergennes, St. Leger, Philip Schuyler, Washington and Baron von Riedesel—these and others are the characters brought back to life with the deft hand of a skilled historian and tactician to enact again, as it has not been enacted in print before, the crucial days of Ticonderoga, Stanwix, Bennington and Saratoga in The Turning Point of the American Revolution.

In the face of the profound research, accurate investigation and thorough treatment evident on every page of this work, a reviewer—unless equally endowed with analytic and literary ability—who would attempt to criticize adversely Nickerson's book would be a party to an assinine spectacle. The fact is the author has by his researches analyzed a period of the American Revolution not hitherto treated. His characters live, his campaigns develop realistically, his politico-economic situations appear in crystalline form and his conclusions are presented much the same, we feel, as an impartial observer of those days must have reasoned.

In dedicating the volume to Col. Newbold Morris, under whom the author served in the Second Section of the General Staff, A. E. F., Mr. Nickerson raises the question whether he has "succeeded in filling a notorious gap in research, in producing a study of military value, and in writing a readable book." In the opinion of this reviewer the author has accomplished these very worthy ends in a truly marvelous way. By virtue of this and his earlier books Nickerson can lay just claim to a prominent place in the forefront of contemporary historians.

The New International Year Book, 1928. Edited by Herbert Treadwell Wade. New York: Dodd, Mead and Co. 1929.

INTERNATIONAL in scope as well as in title, this latest issue of the Year Book presents a compendium of the world's progress for 1928. Col. John J. Bradley, Infantry, U. S. A. (Ret.), again is the author of the review of things military for the past year, the principal items of American armament development discussed being tanks (and mechanization) and antiaircraft artillery. In addition, Colonel Bradley gives a bird's-eye picture of world-wide military progress.

The unbiased treatment of outstanding events of the year including topics such as the Presidential campaign and election, Prohibition, League of Nations, World Court and Reparations, is worthy of commendation to the respective contributors and to the Editor of the Yearbook, Major Wade—a charter member of the Army Ordnance Association and a World War ordnance officer of distinction.

Elementary Differential Equations. By Thornton C. Fry. New York: D. Van Nostrand Co., Inc. 1929. $2.50.

ACCORDING to the preface this text evolved from lessons in the out-of-hour courses of the Bell Telephone Laboratories. It is remarkable in the very practical approach to a difficult mathematical subject. After some preliminary definitions and explanations of the significance of differential equations there follows a chapter on how differential equations originate in practice, illustrated by examples from the law of mass action, flow of current in an electrical network, the conduction of heat, etc.

The text is limited almost exclusively to the solution of linear differential equations of the first order and those of higher orders with constant coëfficients. The treatment of the problems considered is surprisingly rigorous for a text of such elementary scope and is well adapted to lead the student into more extended study of the subject.

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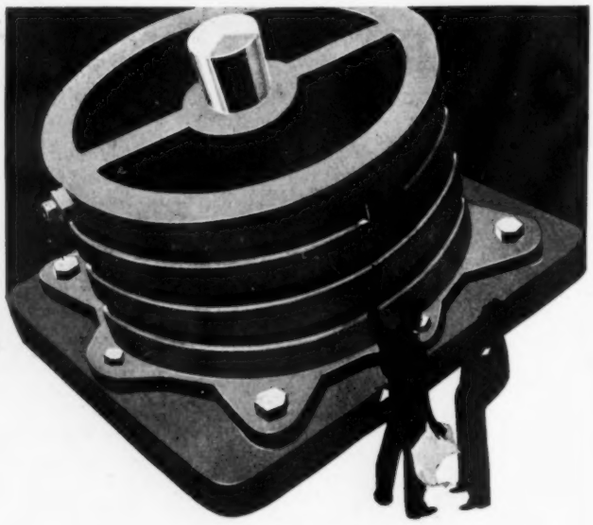

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